Knowledge Dynamics in Innovation Biographies

A Methodological and Spatial Perspective

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Anna Butzin
aus Herne

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Erstgutachterin: **Prof. Dr. Simone Strambach**

Lehrstuhl für Geographie der
Dienstleistungen, Kommunikation
und Innovation
Philipps-Universität Marburg

Zweitgutachter: **Prof Dr. Ivo Mossig**

Forschungsbereich
Wirtschafts- und Sozialgeographie
Institut für Geographie
Universität Bremen

Preface

The doctoral thesis includes the following three papers:

Paper I: Butzin, A. and Widmaier, B.: Exploring Territorial Knowledge Dynamics with Innovation Biographies. The paper is currently under review in *Regional Studies* and supposed to be part of a special issue on "Territorial Knowledge Dynamics" edited by Jeannerat, H. and Crevoisier, O.

Paper II: Butzin, A.: The Nature of Knowledge Generation and Application in Tourism Innovation. This paper is under review in *Tourism Management.*

Paper III: Butzin, A. and Rehfeld, D. (2013): The balance of change and continuity in the German construction sector's development path. In: *Zeitschrift für Wirtschaftsgeographie*, 57(1-2), Special Issue: „Reconceptualizing change: Path dependency, Path plasticity, Knowledge combination", edited by Strambach, S. and Halkier, H., pp. 15-26.

The percentage of the authors' contributions to the respective paper is as follows:

Paper I: Butzin, A. (80%) & Widmaier, B. (20%)
Paper II: Butzin, A. (100%)
Paper III: Butzin, A. (80%) & Rehfeld, D. (20%)

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Abstract

The dissertation at hand analyses knowledge dynamics in innovation processes from a methodological and spatial perspective. By applying a micro-level and process-based view, it contributes to recent research about knowledge creation in innovation. This is implemented with the novel research approach of Innovation Biographies that enables to empirically study the time-spatial unfolding of knowledge in innovation processes. The thesis follows three aims:

- To analyse the nature of knowledge dynamics in innovation processes from idea to implementation according to content, actor constellations and the related micro-geography.
- To explicate the research approach of Innovation Biographies and to embed it into the wider methodological array of economic geography, by assessing the value-added of its results in relation to other empirical approaches that analyse knowledge generation and social interaction in innovation.
- To study sectoral innovation specifics within tourism and construction by analysing the mutual influence of knowledge dynamics and the geographical and social context in concrete innovation processes, and by interpreting findings in light of the sectors' particular distinctions.

The essential finding contributing to the first aim is that knowledge combinations from different sectors and scales have had decisive influence on the analysed innovation processes. High-tech knowledge was combined with low-tech knowledge; production structures of the automotive industry influenced those of prefabricated houses, football clubs of the German Bundes league cooperated with tourism actors, etc. The geography of knowledge dynamics revealed a multi-scalar scope, even if impact of different scales varied according to sectoral and socio-spatial contexts in which innovation emerged and gained momentum. Furthermore, in contrast to mainstream assumptions, the actor networks of the innovations were only to a limited extent based on previously existing trustful relations. Networks have rather been constituted by a mixture of actors known and unknown to the innovating organisation in order to account for the arising novelty.

Referring to the second aim, findings revealed that the micro-level approach of Innovation Biographies provides substantially enriched insight into knowledge creation, its dynamics and time-spatial patterns of innovation. Thus, Innovation Biographies offer a relevant and complementary perspective as compared to other research approaches in economic geography. Through a specific combination of interviewing techniques, network analyses, and visualisations, it is possible to reconstruct the generation of knowledge in innovation creation from idea to implementation. However, drawbacks, e.g. concerning the fuzziness of the precise beginning and end of an innovation process and strong reliance on cooperation of interview partners remain.

As to the third aim, knowledge dynamics and innovation behaviour in tourism and construction are heavily influenced by spatial distinctions of the sectors' production structures. In tourism, the density of competitors causes massive competition and frequent imitation of innovation. Two types of innovation strategies counteracting competition have been elaborated. The first is labelled "assimilation", the second "distinction". In the former strategy, proximate actors are involved in knowledge generation. By incorporating actors that otherwise could be potential competitors, a lever is installed that prevents imitation. Within the latter strategy, competitive advantage is achieved through the incorporation of knowledge from actors located in other countries. Utilising internationally sourced, for others not easily accessible knowledge, allows innovators to develop unique services that cannot be immediately imitated by others.

The construction sector is characterised through strongly localised, temporary, project-based structures that result in renewed knowledge generation in every new building project and therewith in costly repetitive actions. Current innovation strategies, therefore, strive to overcome spatial constraints and project-based structures, e.g. through prefabrication or service-orientation. These innovation strategies are crucially shaped by knowledge combinations.

Zusammenfassung

Die vorliegende Dissertation analysiert die Wissensdynamik in Innovationsprozessen aus methodologischer und räumlicher Perspektive. Durch prozessorientierte Forschung auf der Mikroebene leistet sie einen Beitrag zur aktuellen Debatte über Wissensgenerierung in Innovationsprozessen. Dies wird anhand des neuartigen Ansatzes der Innovationsbiographien, mit dem die empirische Erfassung und Analyse der zeit-räumlichen Entfaltung von Wissen in Innovationsprozessen möglich ist, umgesetzt. Die Arbeit verfolgt drei Ziele:

- Die Analyse der Wissensdynamik in Innovationsprozessen – von der ersten Idee bis zur Implementierung – mit Bezug auf die Wissensinhalte, Akteurskonstellationen und der damit verbundenen Mikrogeographie.
- Die Darlegung des Forschungsansatzes der Innovationbiographien und seine Einbettung in das breitere Methodenspektrum der Wirtschaftsgeographie. Dies erfolgt anhand der Beurteilung seines Mehrwerts im Vergleich zu anderen, die Wissensentstehung und soziale Interaktionen in Innovationsprozessen analysierenden Forschungsansätzen.
- Die Analyse sektoraler Innovationsspezifika des Tourismussektors und des Baugewerbes bezüglich des wechselseitigen Einflusses von Wissensdynamiken und des geographischen und sozialen Kontexts, sowie die Interpretation der Ergebnisse im Lichte der sektoralen Besonderheiten.

Hinsichtlich des ersten Ziels zeigt sich, dass der Kombination von Wissen aus verschiedenen Sektoren und Maßstabsebenen eine entscheidende Wirkung auf die untersuchten Innovationsprozesse zukam. High-Tech-Wissen wurde mit Low-Tech-Wissen kombiniert, bestimmte Produktionsstrukturen der Automobilindustrie haben diejenigen von Fertighäusern beeinflusst, die Kooperation von Fußballvereinen und Akteuren des Tourismussektors führte zu touristischen Innovationen, etc. Die Geographie der Wissensdynamik ließ einen multiskalaren Handlungsraum erkennen, auch wenn der Einfluss verschiedener Maßstäbe, in denen die Innovation entstand, in seinem sektoralen und sozialräumlichen Kontext variierte. Zudem, und im Kontrast zu gängigen Annahmen, basierten die innovierenden Akteursnetzwerke nur in beschränktem Umfang auf bereits im Vorhinein bestehenden, vertrauensvollen Beziehungen. Das zur Innovationsentwicklung beitragende Netzwerk wurde mit

bekannten und unbekannten Partnern gebildet, um der Neuartigkeit der Entwicklung – und damit auch dem neu zu generierenden Wissen, Rechnung zu tragen.

In Bezug auf das zweite Ziel liefert der Forschungsansatz der Innovationsbiographien tiefgehende und reichhaltige Einsichten in die Wissensgenerierung, deren Dynamik und in die zeit-räumlichen Innovationsmuster. Innovationsbiographien bieten somit eine relevante ergänzende Perspektive im Vergleich zu anderen Forschungsansätzen der Wirtschaftsgeographie. Durch eine spezielle Kombination von Interviewtechniken, Netzwerkanalysen und Visualisierungen ist es möglich, die Wissensgenerierung im Innovationsprozess von der Idee bis zur Umsetzung zu rekonstruieren. Jedoch bleiben Schwachstellen festzuhalten. Inhaltlich ist hier insbesondere die Unschärfe von genauem Beginn und Ende eines Innovationsprozesses zu nennen, methodisch problematisch stellt sich zudem die Abhängigkeit von einer zuverlässigen Kooperation mit dem Interviewpartner dar.

Die Analyse sektoraler Innovationsspezifika als das dritte Ziel der Arbeit zeigt, dass die Wissensdynamik und das Innovationsverhalten im Tourismus und im Baugewerbe stark von räumlichen Unterschieden ihrer Dienstleistungs- und Produktionsstrukturen beeinflusst sind. Im Tourismus verursacht die Dichte der Konkurrenten einen massiven Wettbewerb, der in die häufige Nachahmung von Innovationen mündet. In den untersuchten Innovationsprozessen sind zur Begegnung dieses Wettbewerbs zwei Typen von Strategien entwickelt worden, welche als „Assimilation“ und als „Distinktion“ zu verstehen sind. Über die Assimilation werden Akteure aus räumlicher Nähe in die Wissensentstehung integriert. Diese Kooperation mit potenziellen Konkurrenten soll Imitationen vorbeugen. In der Distinktion werden Wettbewerbsvorteile gegenüber den lokalen Konkurrenten angestrebt, indem nur schwer zugängliches Wissen internationaler Akteure einbezogen wird. Das Baugewerbe zeichnet sich durch räumlich und temporär stark differenzierte, sowie projektbasierte Strukturen aus, durch die Wissen in den einzelnen Bauprojekten kostspielig immer wieder neu generiert werden muss. Gegenwärtige Innovationsstrategien begegnen diesem Charakteristikum über die Produktion von Fertigteilen oder neue Dienstleistungsangebote. Sie sind in besonderer Weise durch Kombinationen von Wissen aus unterschiedlichen Sektoren geprägt.

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CHAPTER 1

Introduction

What are the characteristics of knowledge generation and application in innovation processes? How do knowledge dynamics evolve over time within the network of participating actors? How do knowledge dynamics emerge in light of different regional, national and global spatial scales from which the knowledge might originate? What sectoral conditions influence knowledge dynamics and social interaction in the process of innovation creation?

These questions are the central starting and discussion point for the research undertaken within this dissertation. Thereby, the intention is to contribute to closing a research issue that has largely been left open in economic geography: Though the importance of knowledge in innovation, and of innovation itself as a central driving force of economic growth is undisputed in the scientific community, a debate on furthering our understanding of how knowledge is generated and applied in innovation processes has not been initialised for a long time (Howells 2012; Krätke 2010). This would, however, particularly substantiate insight into the features and mechanisms of innovation and thereby into an essential component of economic development.

Within the concerned research communities of economic geography and regional studies, emphasis has first and foremost been put on regionally-focussed territorial innovation models (Moulaert and Sekia 2003; Camagni 1991; Fromhold-Eisebith 1995) and their constituting elements, i.e. industry agglomerations, sectoral networks, and factors of production; and been related to the question in how far these impact on knowledge-spillovers, innovation capacity and regionally endogenous economic growth. In addition, analyses addressed specific innovation determinants underpinning the embededdness of innovation, i.e. localised learning, and trustful relationships among different actor constellations, as well as the distinctiveness of their specific local socio-cultural background (Maskell and Malmberg 1999). The

key interest was to assess how these various context determinants influence each other and constitute a system of innovation (Cooke 1998).

The lack of rigour concerning knowledge dynamics might be explained through the early developed Polanyi continuum of tacit and explicit (or codified) knowledge (Polanyi 1967). According to Polanyi, tacit knowledge is not easy to communicate – "we know more than we can tell" (Polanyi 1967: 4) – and face-to-face contact is assumed to be a prerequisite for its transfer from one person to the other. Explicit knowledge can be codified and transferred across larger distances. The continuum enabled regional innovation scholars to refer to innovation as being learning intensive and essentially characterised through "sticky" tacit knowledge that remains local and does not flow easily (Howells 2002). Based upon this understanding, it was possible to conceptualise innovation without the immediate need of further concretising the knowledge factor through subsequent research and instead focus on explaining the context determinants mentioned above. The knowledge categories of Lundvall and Johnson (1994), namely know-what, -why, -how, and -who, likewise labelled as being essential for innovation development might have played a similar role.

Only very recently, there is growing interest in studying and concretising the relation of knowledge dynamics and innovation creation from a spatial perspective, resulting in an increasingly active field of research (Howells 2012; Strambach 2008; Moodysson and Jonsson 2007; Ibert 2007; Amin and Cohendet 2004). Explanations for the upsurge relate to an endogenously derived body of research. It was stimulated by progress in particular achieved from broadening the regional focus in order to include interaction on the global scale and related knowledge sources (Bathelt et al. 2004; Schmitz and Strambach 2009). By becoming more substantiated, this research has led to a certain pressure to go beyond the tacit/codified distinction (Asheim 2007), and to formulate questions through which the functions and mechanisms, i.e. the dynamics of knowledge in innovation would be studied in greater depth. This not only shifts focus from innovation to knowledge as their key resource, but also to the global dimension of innovation creation (Crevoisier and Jeannerat 2009).

Aims and Scope of the Dissertation

This thesis contributes to the young research field attracted by studying the relation of knowledge dynamics and innovation creation from a spatial perspective. It empirically derives new findings about characteristics and spatial patterns of knowledge dynamics. This is achieved by exploring the process of knowledge generation in concrete innovation projects with respect to the content and actor constellations; as well as by analysing and interpreting the spatial topography resulting from the interactions among the actors involved.

Next to this deeply content-related interest, the aims and scope of the thesis are strongly determined by underpinning the novel research approach of Innovation Biographies that was applied to conduct field work.[1] To give an overview, Innovation Biographies enable to study the time-spatial evolution of knowledge dynamics in concrete innovation processes. Through a specific combination of interviewing techniques, network analyses, and visualisations, it is possible to reconstruct innovation creation from the first idea until its implementation, i.e. to disclose the biography of an innovation process. Therefore, the term "Innovation Biography" refers to both, the research procedure and its outcome. With the explicit focus on concrete innovation processes, Innovation Biographies enable analysis of micro-level activities.

Until now, Innovation Biographies have been applied in three major research projects in which the author of this thesis was involved and in which new insight concerning the constitution of innovation processes was generated.[2] However, as novelty generally needs to be explained, justified, and verified, so does the research approach of Innovation Biographies. This undertaking can be understood as a process in which insight and knowledge about the research approach co-evolve with its application in the field. In so far, this

[1] The research approach of Innovation Biographies was initiated by Professor Ernst Helmstädter at the Institute for Work and Technology (IAT) Gelsenkirchen, Germany. As a researcher working at the Institute for Work and Technology, the author of this thesis was strongly involved in developing and testing Innovation Biographies in numerous field studies.

[2] The projects were funded by the Volkswagen Foundation (contract II/81 419, coordinated by IAT), the European Commission's FP6 Programme (contract 006187 IAT was work package leader), and by the Federal Ministry for Construction, Germany (contract Z.6-10.08.18.7-07.01, coordinated by IAT).

thesis also strives to provide a substantially enriched and differentiated piece of work on Innovation Biographies in terms of research procedure, data and scope of results. Hereby, outstanding questions and issues left unaddressed in earlier publications (Butzin et al. 2012), in particular concerning the relation to other methods and the research gap filled by findings derived from Innovation Biographies, shall be clarified.

Against this background, the thesis has two overall aims of which the first is related to analysing knowledge dynamics in innovation creation from a spatial perspective. The second is related to the further substantiation of the Innovation Biography approach. The aims are formulated as follows:

1) To analyse the nature of knowledge dynamics in innovation processes from idea to implementation according to content, actor constellations and the related micro-geography.

2) To explicate the research approach of Innovation Biographies and to embed it into the wider methodological array of economic geography, by assessing the value-added of its results in relation to other empirical approaches that analyse knowledge generation and social interaction in innovation.

It is strived to achieve the aims by analysing empirical material derived from Innovation Biographies carried out in the course of research projects in the construction and tourism sectors.[3] Both sectors have a "traditional" image through which they are perceived as being positioned far behind "modern", well-researched sectors proclaimed as characteristically for today's economic dynamics (e.g. high-tech, new services, and creative sectors). As a result, they have been vastly neglected in the relevant innovation literature. However, this does not imply that sectors within a traditional context are not knowledge intensive and innovative, since they, as all sectors, need to renew themselves on a constant basis to remain competitive. Therefore, construction and tourism are, also because of interesting geographical and social con-

[3] Contract no. Z.6-10.08.18.7-07.01 and 006187, cp. footnote no. 2

text determinants influencing knowledge application in innovation that will be discussed in later chapters, even more so two exciting research areas.

Consequently, the thesis strives to further the body of knowledge in the two sectoral contexts as a subsequent aim. Complementary to focussing on the intrinsic dimension of knowledge dynamics mirrored in the first aim, this aim strives to shed light on knowledge dynamics' relation to sectoral context determinants. It is formulated as follows:

3) To study sectoral innovation specifics within construction and tourism by analysing the mutual influence of knowledge dynamics and the geographical and social context in concrete innovation processes, and by interpreting findings in light of the sectors' particular distinctions.

Each of the aims will be discussed in detail in the course of this thesis. Results will be synthesised in the concluding part.

CHAPTER 2

The Spatiality of Knowledge Dynamics in Innovation Processes

2.1 Introduction

This section is dedicated to elaborating key arguments of prominent debates in economic geography and regional studies that are concerned about the spatiality of knowledge in innovation. The overall aim is to position the scope of this thesis in light of recent concepts and research findings. In light of this purpose, the key question of the synthesis is: *what do we learn from the debates' conceptualisations and findings in order to understand the spatiality of knowledge dynamics in innovation processes and, in turn, what are the remaining open research issues?*

Before starting the discussion, the understanding of essential notions of this dissertation, namely knowledge and knowledge dynamics, innovation and innovation processes shall be introduced. The section continues with a condensed analysis of scope and findings of territorial innovation models (TIMs). For a long time, TIMs, i.e. regional innovation systems (Braczyk et al. 1998), industrial districts (Becattini 2004), innovative milieu (Camagni 1991), etc., have been, and still are, the major framework for studying the relation of innovation, space and knowledge generation. Findings of this approach, e.g. about the systemic dimension of innovation, about innovation networks and about specific actor constellations (i.e. triple-helix – public and private sector, research institutions, cp- Etzkowitz and Leydesdorff 2000), have had key influence, not only within the scientific community. They have also been implemented in strategies and programmes of economic development organisations and remain to be an important point of reference.

The section then elaborates key arguments of current debates that are explicitly focussing on the attributes of economically relevant knowledge and knowledge exchange mechanisms in innovation. These are the debates on

knowledge-spillovers, on forms of proximity, on differentiated knowledge bases, and on territorial knowledge dynamics. From a conceptual point of view, their concern is to study the influence of the (growing) mobility and multi-locality of knowledge as well as of socio-cultural and symbolic forms of knowledge on innovation activities. Parts of the debates' findings and theoretical considerations (implicitly or more clearly) challenge the framework of TIMs and their strong orientation towards the regional level, and imply adaptation of existing, or development of new conceptualisations.

The section concludes with a discussion of open research issues.

2.2 Knowledge and Knowledge Dynamics, Innovation and Innovation Processes

The classifications of knowledge referred to in the introduction, i.e. the tacit and codified continuum (Polanyi 1967) and the know-what, -why, -how, and -who categories (Lundvall and Johnson 1994) relate to a theoretical perspective in which knowledge is discussed as an object, i.e. a thing-like property (Ibert 2007: 105). But knowledge can also be considered as a "capacity to act" (Stehr 2001: 89), therewith being inseparable situated in social practices (Orlikowski 2002, Ibert 2007, Strambach and Klement 2012, Crevoisier and Jeannerat 2009). In this second perspective, knowledge is in a constant flux of reconstitution as it gets new connotation when faced with new frames of action (Orlikowski 2002). Knowledge is perceived as a crucially subjective dimension enabling individuals to act through "knowing in practice" (Orlikowski 2002). The *generation* of knowledge dependents on collective action, since learning is enabled through interacting with others (Howells 2012), i.e. knowledge generation is the outcome of a procedural collective learning endeavour (Strambach and Klement 2012).

For the nature of research undertaken in this thesis, knowledge is approached from the theoretical perspective of "knowing in practice". The prerequisite procedural understanding is applied by focussing on knowledge generation, application and interpretation in the situation of innovation development. Thereby, the collective social endeavour, put in practice by the

engagement of actors in developing further an innovative idea is a central point of reference.

Knowledge dynamics are closely related to the collective practice of knowledge generation. According to Strambach (2008), knowledge dynamics are understood as "the dynamics that are unfolding from processes of creation, using, transforming, moving and diffusing knowledge" (153). This perception paves the way for incorporating the issue of actors into the theoretical discussion, as the notions of "creating", "using", "transforming", etc. are activities essentially relating to the individuals involved. Thereby the perception underlines influence of human expertise – or the knowing of actors – as a driving force of knowledge generation (cp. also Amin and Cohendet 2004, Howells 2012). Therefore, the unfolding of knowledge dynamics is a highly localised and highly context dependent practice (Strambach and Klement 2012, Amin and Cohendet 2004, Howells 2012, Ibert 2007). Since generating knowledge depends on the knowledge of others, it also depends on others' *availability, specialisation* and in consequence also on the *location* where access to knowledge is enabled. This dependency is most observable when considering the uneven distribution of specialised knowledge in countries and around the globe.

Innovation processes are perceived as social situations in which knowledge is put into practice, further developed and enriched through the interaction with others. Innovation processes explicitly target at the development and implementation of an innovative idea and include a steep learning curve that co-evolves with knowledge dynamics. A number of crucial characteristics are ascribed to innovation processes: Apart from *context and spatial dependency* as a consequence of knowledge-intensity (cp. above), *non-linearity* arises through various forms of trial, error and feedback loops arising in innovation processes (Kline and Rosenberg 1986). High *uncertainty* is connected to the unknown (since novel) nature of the outcome. Success cannot be guaranteed and there is considerable risk to fail (Koschatzky 2001). Innovation processes are particularly *complex*. Therefore, the social network through which they are developed not only generates knowledge, as in addition, it also fulfils the function of risk distribution (Asheim and Gertler 2005).

Innovations are the successful outcome of innovation processes. They can have various shapes, e.g. product, organisational, sustainable and social innovations. In contrast to definitions according to which innovations can be distinguished from inventions if they are introduced on the market (product innovations), or used within a production process (process innovations) (cp. Smith 2005), the understanding of innovations applied in this thesis is inventions *being recognised and applied by relevant target groups* (cp. also Rogers 1983: 11). The advantage is a broadened scope that appreciates innovative developments beyond a mere product and profit-maximising orientation. This also has implications on the aspect of novelty. Rather than perceiving radically new outcomes as the sole criterion, the significant initiation of change in existing organisational, local or regional structures is considered innovative, too. Change is considered significant, if it is the outcome of a knowledge-intensive learning process.

In this section, theoretical considerations of essential notions for this research have been discussed. In what follows, territorial innovation models (TIMs) will be outlined as they are the major point of departure on which current debates on spatial aspects of knowledge application in innovation are built upon.

2.3 Scope and Findings of TIMs in a Nutshell

In search of economic development concepts counteracting the negative effects of massive industrial restructuring beginning in the 1970s, distinct regions were regarded as prototypes in which economic competitiveness could be maintained or even increased; ideally through the early attraction of high-technology industries and/or through the stimulation of endogenous growth potentials. The most prominent European examples were Baden-Württemberg in Germany (engineering) and the Italian Emilia-Romagna (design, manufacturing), which were only excelled by Silicon Valley (ICT) in the US. Much research concentrated on understanding these regional economies' success factors. TIMs have been developed in this light (Moulaert and Sekia 2003).

The underlying notion of TIMs is that the diffusion of knowledge, learning, and the development of innovation can be achieved best through trustfully cooperating with neighbouring firms or organizations. Accordingly, innovation development depends on interactions taking place within spatial proximity (Camagni 1991: Cooke and Morgan 1998: Asheim and Gertler 2005; Lorentzen 2008). In particular, it is stated that the exchange of tacit knowledge as the key to innovation requires proximity, i.e. a common socio-cultural, institutional, and cognitive background that facilitates communication and increases trust among actors.

Through certain intensity of collective learning within a local system, knowledge creation is supposed to be driven by the accumulation of knowledge from neighbouring sources (Maskell and Malmberg 1999). Economic success is thus considered endogenous and based on a regional trajectory of growth. It is substantially furthered by the cooperation of a specific actor constellation defined as a "triple-helix" of firms, public agents, and research institutions, supported by intermediaries to accelerate technology transfer and knowledge valorisation (Etzkowitz and Leydesdorff 2000).

Many of the findings derived from research on TIMs are widely appreciated. They can best summarised as a broadly accepted understanding of innovation generation being a knowledge-intensive and systemic learning process within a trust-based actor network that, because of these attributes, has a strong local dimension. Furthermore, many TIMs' *allegedly* clear routes to support economic growth, interpreted along the lines of high-tech industries, networking and triple-helix-constellations, encountered broad policy-resonance.[4]

The strong orientation towards the regional level and the resulting simplified qualification of linkages within TIMs has been criticised. Since the tacit knowledge was assumed to be exchanged only at the regional level, the question in how far global links do influence innovation activities has not received much

[4] Even though it turned out soon that the mere support of high-tech industries did not result in economic growth. These industries were and are massively subsidised in a plethora of regions as a result of misinterpreting the matter of *endogenous growth potentials* mentioned in the TIM literature.

attention (Oinas and Malecki 2002; Bathlet et al. 2004; cp. also the section "Concretising Local/Global Pipelines: Territorial Knowledge Dynamics" on page 17 this chapter). Another critical argument is the production-oriented conceptualisation of TIMs, leaving unaddressed the strong influence of customer demands and societal trends on innovation generation (Grabher et al. 2008).

2.4 Knowledge-Centred Debates

When shifting focus from regional economies and associated social networks to dynamics stimulated by the mobility and multi-locality of knowledge as well as by cross-sector innovation, there must be consequences for the proximity thesis and knowledge applied in innovation activities. It is the aim of the current debates, in this thesis labelled "knowledge-centred debates", in economic geography to analyse and understand these consequences. Due to the common starting point, some conceptual overlap of the debates is inevitable, but they can nevertheless be analytically differentiated according to their key arguments, specific research objects and levels of abstraction. The synthesis of each debate concludes with a reflection addressing this chapter's key question. Concentrating on key arguments of these debates instead of providing an in-depth discussion of related thoughts and reflections might bring along the shortcoming of constructing a stylised picture that does not account for the debates' fine distinctions and multiple considerations. On the other hand, the advantage is to enable comparison of their key features, findings and assumptions. Therewith, an elaboration of the entire range and scope of relevant debates is carried out (for a similar argument cp. Ibert 2007).

2.4.1 (Localised) Knowledge-Spillovers

The debate on knowledge-spillovers is, in fact, linked to the question how, and how far, knowledge is transferred in space (Döring and Schnellenbach 2006). The debate has come a long way and roots in Marshall's explanations for economic agglomeration, according to which knowledge-spillovers are

related to *specialisation* as one of the three factors of industrial co-location (next to labour market pooling and economies of specialisation) (Thomson and Fox-Kean 2004; Frenken et al. 2007). In contrast, Jacobs (1969) has put forward an understanding of knowledge-spillovers appearing due to the *variety* of agglomerated industries in metropolitan areas which is a source of creativity and innovation. These so-called Jacobs-spillovers have spurred the recent debate on "related variety" (Frenken et al. 2007) of regional industries as a specific regional economic strength.

In many empirical studies (for an overview cp. Döring and Schnellenbach 2006) relevance for economic growth has been tested, thus, "the statement that […] both types of knowledge spillovers are empirically relevant is a rather safe claim" (Döring and Schnellenbach 2006: 385). For example referring to Marshall's spillovers, Jaffe, Traitenberg and Henderson (1993) did find a higher probability for a patent to be cited in the application of another patent, when both patents originated from the same geographical area. They concluded that spatial proximity matters for the knowledge-spillovers appearing between the first patent and the development of the second.

What these findings could not answer is a question raised by Breschi and Lissoni (2009: 442), namely through "what kind of mechanisms the knowledge is transmitted from the origin (the cited patent) to the destination (the citing patent)?" Taking this question as starting point, Breschi and Lissoni (2009) matched cited and citing patents with the mobility and social networks of inventors. In their findings, geographical proximity of cited and citing patents almost entirely overlaps either with the names and addresses of inventors listed in the patent application, or with their social networks. In consequence, social relations, namely researchers that changed job or cooperated with research teams of other firms, are the connecting element between cited and citing patents. Geographical proximity is thus a "by-product" of the limited mobility and bounded networks of researchers, which prefer to change their job or to cooperate only if it is within reasonable distance

But also with reference to Jacobs-spillovers, the question of transfer channels has long been an open one (Schmidt 2012; Döring and Schnellenbach 2006). Moreover, researchers' mobility and social networks might not have been the

only transfer channel in case of Marshall-spillovers. In differentiated elaborations of knowledge transfer channels (cp. e.g. Schmidt 2012; Döring and Schnellenbach 2006), therefore, next to market relations (trade of goods, transfer of human capital), channels outside market relations, e.g. the World Wide Web, publications, and catalogues, as well as associations and professional communities, have proved to be of relevance for knowledge transfer, especially of non-technological knowledge (cp. Schmidt 2012: 282-283). With the broadening of possible knowledge transfer channels and the analysis of the kind of knowledge being transferred, some major critical points of the knowledge-spillover debate, e.g. concerning a homogeneous view upon knowledge (Audretsch and Feldman 2004) have been relaxed.

Summary referring to this chapter's key question[5]:

- Knowledge spillovers occur through specialisation (cp. e.g. Thomson and Fox-Kean 2004 with reference to Marshall,) and industrial variety in metropolitan areas (cp. e.g. Jacobs 1969; Frenken et al. 2007).
- Knowledge does not "flow", or "spill over", it is to a considerable extent transferred by people through a variety of different channels (cp. e.g. Breschi and Lissoni 2009; Schmidt 2012).
- The mobility of people is largely confined to a geographical area (cp. synthesis of Malecki 2010, Breschi and Lissoni 2009).
- Social networks are a major channel of knowledge transfer; however, there exist also other channels, such as the trade of goods, the World Wide Web and catalogues (cp. e.g. Schmidt 2012; Döring and Schnellenbach 2006).

2.4.2 Modes of Proximity

If spatial proximity of knowledge transfer is a result of peoples' mobility, then there must be additional attributes of proximity that facilitate

[5] The list strives to concentrate on the key lines of argumentation of the debate. The references following each argument shall be understood as *exemplary* sources, in fact, many more authors have contributed to underpinning the findings.

knowledge transfer. To enable in-depth analysis, further analytical categories have been defined, which are distinguished according to cognitive, organisational, social, and institutional forms of proximity (Boschma 2005; Torre and Rallet 2005).[6] In so doing, scope has been broadened, allowing the examination of the different proximities' spatial patterns and their distinct influence on knowledge creation (including fairs and conferences, i.e. temporal geographical proximity, cp. Maskell et al. 2006). It was assumed that these other forms of proximity could help bridging spatial distance when actors interacted with each other (Healy and Morgan 2012).

Furthermore, knowledge transfer and exchange could now be studied as a *relational process* with multiple dimensions, instead of as a purely physical (i.e. geographical) phenomenon (Balland et al. 2013a; cp. also Howells 2012 and Bathelt and Glückler 2003). "The proximity approach is thus more a method of understanding or analysing innovation at the local level than a theory in itself" (Carrincazeaux and Coris 2011: 271).

Balland et al. (2013a) differentiate between institutionalist, interactionist, and evolutionary perspectives on the analysis of proximity. The first perspective has its analytical focus on the context of interactions and refers to shared norms and values shaping interactions. In contrast, the second perspective analyses actual micro-level interactions instead of their contextual embeddedness; and the third strives to analyse proximity dynamics through which micro-level interactions are formed over time, including possible changes of the proximity forms.

Very recently, the evolutionary perspective on proximity dynamics has flourished and some first empirical studies are published based on longitudinal social network data. The studies particularly focus on the spatiality of social network evolution with respect to firms (Broeckel 2012), R&D collaborations (Balland 2012), or within industries (Ter Wal 2013; Balland et al. 2013b).

[6] Cognitive proximity: actors share similar competences and a common knowledge base; organizational proximity: common arrangements (e.g. networks, communities) as mechanisms facilitating knowledge transfer; social proximity: socially embedded micro-level relations of actors; institutional proximity: a shared institutional framework at the macro-level (Boschma 2005).

Findings obviously are very specific and will require further synthesis once the research stream is more established. For example did Balland (2012) conclude in the case of European research collaborations on satellite navigation that "organizations prefer to start partnership when they share one or more forms of proximity, except for the cognitive and social proximity [...] cognitive proximity has not a significant effect on collaboration" (Balland 2012: 753).

In contrast, Broekel (2012) found that cognitive and geographic proximity, as well as cognitive and institutional proximity co-evolve. And the results of Ter Wal (2013) hint at spatial proximity to be relevant in early stages of tie formation, and related to the exchange of basic rather than specialised knowledge. Later on, when ties have become more established, firms commence utilising the network as a whole and intensify cooperation with more distant partners.

A critical remark with respect to empirical proximity studies is their reference to very exclusive and highly specialised channels of knowledge exchange (funded R&D collaborations, patent applications), constituted by rather homogeneous actor types. Furthermore, focus is on the structures of ties, rather than on their knowledge content and nodes. There is no insight into the reasons *why* and *how* specific kinds of knowledge shape cooperation.

Summary referring to this chapter's key question[7]:

- Knowledge exchange is a relational process (cp. e.g. Boschma 2005; Howells 2012; Balland et al. 2013a).
- Other forms of proximity help bridging distance within the process of knowledge exchange (which form(s) exactly, is subject to further research) (cp. also Healy and Morgan 2012).
- Spatial proximity seems to be a decisive factor for knowledge exchange in the early phase of economic action (cp. e.g. Ter Wal 2013).

[7] See footnote no. 5

2.4.3 Differentiated Knowledge Bases

Within the debate on knowledge bases it is suggested that sectors have varying ways of learning and knowledge creation and that these can be differentiated according to an analytical, synthetic and symbolic knowledge base (Asheim 2007). Thereby, two essentially new aspects are addressed. Firstly, focus is on the *content* of knowledge creation and innovative activity and it is assessed how the content of interactions shapes network structures and interactions. Secondly, the differentiated knowledge base concept embodies a *cross-sectoral* understanding of economic activities that implies commonalities in knowledge generation across sectoral boundaries (Martin and Moodyson 2011).

In an analytical knowledge base, knowledge is generated while applying natural laws, modelling and rationalized processes. Typical applications are within basic sciences, bio- or nanotechnology where knowledge is highly formalized, universally valid and where there are global codes to understand it. In synthetic knowledge bases, knowledge is mainly generated through new combinations of existing knowledge (as in engineering) with the major modes of learning being developing and testing, trial and error. Symbolic knowledge bases (i.e. art-based industries such as media and design) are strongly influenced through tacit knowledge since innovations need to be authentic in order to be adapted in specific socio-cultural contexts. As such, crucial parts of the knowledge creation process are determined by elements of localized learning (Asheim 2007; Martin and Moodyson 2011; Manniche 2012).

As in case of studying evolvement of proximity dynamics, empirical research of knowledge bases is at an early stage. In an examination of the different knowledge bases in Scania, Sweden, Martin and Moodysson (2011) find (through social network analyses) that the geographical scope of knowledge exchange is global in case of analytically-based industries and much more nationally and regionally based in case of synthetic and symbolic industries. Strambach and Klement (2012) develop further the idea of cross-sectoral knowledge exchange and analyse actual interactions of innovation processes according to combinations of analytical, synthetic or symbolic knowledge.

They conclude that knowledge exchange can also take place across knowledge bases in innovation processes, mainly between analytical and symbolic, and between synthetic and symbolic industries.

In the future, it might be an option to carry out comparative analyses of learning routines within a knowledge base (intra knowledge-base analyses, e.g. of different symbolic sectors), in order to empirically test the threefold differentiation and to substantiate assumptions on the different learning mechanisms.

Summary referring to this chapter's key question[8]:

- The characteristics of knowledge creation are differentiated according to analytical, synthetic, and symbolic knowledge bases (Asheim 2007).
- The geographical scope of interactions varies between knowledge bases. Tendencies are towards global interactions in case of sectors with analytical knowledge bases, and national and regional level interactions in case of sectors with a synthetic and symbolic knowledge base (Martin and Moodysson 2011).
- Knowledge exchange can happen across sectoral borders and across knowledge bases (Strambach and Klement 2012).

2.4.4 Concretising Local/Global Pipelines: Territorial Knowledge Dynamics

Due to the strong emphasis of the regional level in TIMs, there have continuously been studies pointing to the global connections regionally agglomerated industries establish and maintain in order to stay competitive (Amin and Thrift 1992; Asheim 1999; Gertler and Levitte 2005). The studies' arguments have been integrated into TIM concepts in a somewhat crude manner, according to which global networks contained the exchange of codified knowledge, and local networks the exchange of tacit knowledge. This simplifying dichotomy could be relaxed through arguments related to the metaphor of "global pipelines and local buzz" installed by Bathelt et al. (2004). The au-

[8] See footnote no. 5

thors brought to the fore that learning of clustered industries exists of both, local and global connections and that tacit knowledge can well be exchanged through channels other than those on the local level (cp. also arguments of the proximity discussion).

The concept of territorial knowledge dynamics (Crevoisier and Jeannerat 2009) aims at updating and concretising the resulting research agenda. The argument is as follows: In light of an ever increasing multiplicity and mobility of knowledge (provided by ICT, work related travel, the global connectedness of production, international research collaborations, and cross-sector innovation potentials), the decisive factor for successful regions is "[…] the local capacity to formulate entrepreneurial projects and also the ability to mobilize knowledge and competences at medium and long distances" (Crevoisier and Jeannerat 2009: 1226). Successful regional actors take advantage by *anchoring* knowledge originating from multiple locations and by providing added-value, i.e. to contextualize the knowledge in order to generate benefits, before it transcends further around the globe (i.e. it is de-contextualised). The process is labelled as a circulatory paradigm (Crevoisier and Jeannerat 2009).

These multi-local "territorial" knowledge dynamics affect today's regional learning regimes, fuelled by *combinatorial* knowledge originating from distant sources (as opposed to cumulative knowledge discussed in TIMs, cp. page 9), and different sectors (Strambach and Klement 2012).

Jeannerat and Crevoisier (2008) illustrate territorial knowledge dynamics co-evolving with the progressive renewal of the Swiss watch industry in the Canton Jura during the 1990s and onwards. In this case, territorial knowledge dynamics are driven by the establishment of an image related to precision and accuracy on the one hand, and luxury of watches on the other (Jeannerat and Crevoisier 2008: 15). Both features had the aim to increase the aesthetical value of the watch. They were underpinned by numerous cross-sector collaborations targeting at strengthening the connection between Swiss watches and other high-end products (fashion, cars, sport events, etc.), of which the production is based in other territories.

However, until now, the idea of territorial knowledge dynamics is mainly developed on a conceptual level. The mechanisms of how actors establish and maintain distant interactions, and the value of such interactions need to be further integrated.

Summary referring to this chapter's key question[9]:

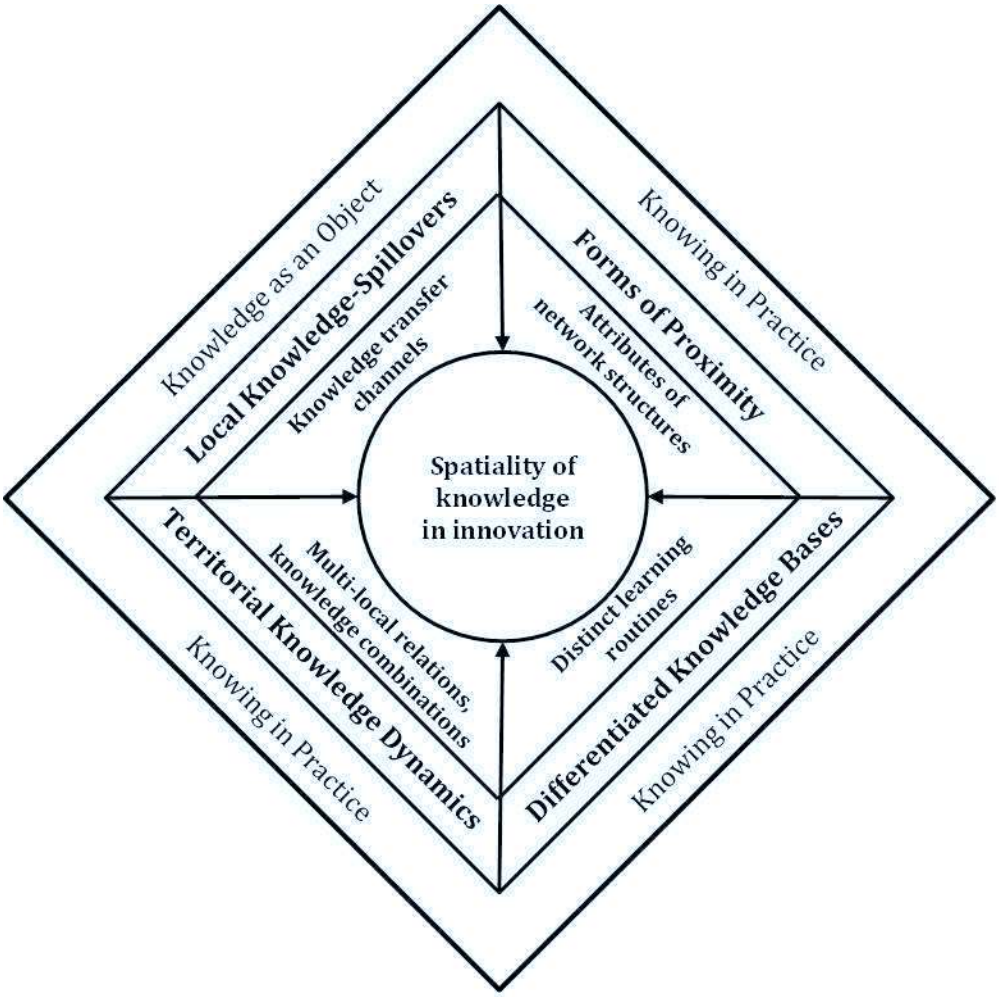
- Today's learning regimes are fuelled by combinatorial knowledge that originates from distant sources and from different sectors (Crevoisier and Jeannerat 2009; Strambach and Klement 2012).
- Successful regional actors take advantage by anchoring knowledge (Crevoisier and Jeannerat 2009).
- The relevance of distant knowledge interactions increases (Crevoisier and Jeannerat 2009).
- Knowledge dynamics can occur across multiple scales (Crevoisier and Jeannerat 2009; Strambach and Klement 2012).

2.5 Discussion of Open Research Issues

The different debates provide a diverse picture on spatial aspects of knowledge dynamics in innovation, leading back to the different approaches and heuristics: The debate on local knowledge-spillovers focuses on knowledge transfer channels, the proximity debate on attributes of network structures, the knowledge base debate on distinct learning routines, and Territorial Knowledge Dynamics on multi-local relations and knowledge combinations. Thereby, the discussion of knowledge in relation to the two theoretical perspectives (cp. page 7) is treated in different ways, as illustrated in figure 1.

[9] See footnote no. 5

Figure 1: Spatiality of Knowledge in Innovation



Source: own illustration

Despite the diverse nature of approaches and findings, it is nevertheless possible to synthesise key findings of the debates. They give an account of what is known about knowledge dynamics in innovation processes and in how far they include differentiated considerations as compared to discussions related to TIMs (cp. table 1).

- Social networks are a major channel of knowledge transfer (local knowledge-spillovers).

- Knowledge exchange is a relational process (modes of proximity).
- Spatial proximity is one out of other modes of proximity. It facilitates the emergence of these other modes (modes of proximity).
- The content of innovative strategies shapes their structures and spatial reach (differentiated knowledge bases).
- The shift from cumulative to combinatorial knowledge results in a process of global knowledge anchoring and circulation (territorial knowledge dynamics).
- Knowledge dynamics can have a multi-scalar dimension (from local to global) (territorial knowledge dynamics).

Table 1: Synthesis of knowledge-centred debates and relation to TIMs

Debate	*Local Knowledge-Spillovers*	*Forms of Proximity*	*Differentiated Knowledge Bases*	*Territorial Knowledge Dynamics*	*Territorial Innovation Models*
Knowledge in innovative actions is approached through...	divers channels of knowledge transfer.	(change in) structural characteristics of the interactions through which knowledge is exchanged.	three taxonomies based on distinct learning routines and interactions.	multi-local relations of innovative places.	Emphasis is put on innovation as a knowledge intensive process, no clear examination of knowledge itself.
Key assumptions & findings	Social networks and the mobility of people are main channels through which knowledge is transferred.	Spatial proximity is one out of other modes of proximity. It facilitates the emergence of these other modes.	The content of innovative interactions shapes their structures and geographical reach.	The shift from cumulative to combinatorial knowledge results in the process of knowledge anchoring and circulation.	Innovation has a strong local dimension. It is developed based on trustful relationships of actors that share a common socio-cultural background.

Source: own compilation

As has been discussed, research on spatial aspects of knowledge in innovation processes is particularly advanced. There are, however, remaining pertinent open research issues that shall be elaborated according to five thematic areas in the following.

Firstly, when extrapolating their arguments, in the end, all debates aim at studying knowledge and its spatial dynamics to better understand the distinctiveness of innovation processes. But they do so within specific *niches* of an innovation process (patents, R&D networks) or by developing abstracted *categories* (knowledge bases, territorial knowledge dynamics). In both cases there is either strong aggregation of quantitative data or high abstraction of existing routines and relationships (qualitative). Either way, emphasis is put on selected units/aspects with the result of a considerably patch-worked, modularised picture of innovation processes. The implications of findings beyond these units remain diffuse. It is an open research issue to assess the scope of their significance for innovation processes *as a whole*.

Secondly, apart from these more methodology-related challenges that cannot be resolved easily, an aspect underdeveloped across the knowledge-centred debates is the role of actors. In fact, knowledge dynamics are inseparable from actors, different *actor types*, and *actor constellations* and the various roles they can play in stimulating knowledge dynamics. With such an undisputable crucial function, actors have massive influence on the emergence and development of knowledge dynamics that might also be driven by specific interests and/or conflicts. There is thus considerable reason to assume that research addressing the role of actors provides further insight into the relation of knowledge and innovation.

Thirdly, the minor attention paid to actors might be the reason why trustful relationships, that have been ascribed a crucially relevant role in the literature on territorial innovation models, do not seem to be conceptualised in the knowledge-centred debates. To recapitulate, a key finding of TIM research was an understanding of innovation generation as being a knowledge-intensive and systemic learning process within a *trust-based actor network.* It is an open question whether the dependence on trust has lowered in current innovative actions and in how far it needs to be integrated as part of future research.

Fourthly, another issue has been left out in the debates, both from a methodological and a conceptual perspective. Knowledge dynamics and flows, emergence of innovation, economic growth, etc., these are all expressions for *de-*

velopment processes and change. But the question how these processes actually happen, how they develop and shape, what concrete variables they have and how they diffuse, is rarely explicated in the literature. This drawback was also noticed earlier by Audretsch and Feldman (2004) who state "It may be that a mapping of the process by which new knowledge is created, externalized and commercialized, hold the key to providing microeconomic linkages to endogenous macroeconomic growth" (2004: 2735). In the same vein Yeung (2003) argues for a process-based methodological framework and the tracing of actor networks to explore the micro-foundations of economic action.

Fifthly, especially the debates on proximities, knowledge bases and territorial knowledge dynamics set-apart from the regional focus. They do so, by branching out their research: Patents and R&D networks, for example, are studied at national or European level, knowledge bases cut across sectors, and territorial knowledge dynamics appear on multiple scales. Though the importance of the regional scale is appreciated in the debates, the branching implies realignment towards broader national and international levels to account for a globalised economy. An alternative hardly established to date is the *micro-level*. It is understood as the most concrete level where actors (individuals) move, cooperate, and generate knowledge and where all actions, local or global in reach, actually take place. Studying knowledge dynamics at the micro-level through analysing the concrete actions of people in firms, project teams, organisations, etc. would be a relevant complementary line of research.

Many of the open research issues lead back to actuality of the debates that are to be further discussed, empirically tested, and developed in the future. However, it is argued that emphasis put on knowledge dynamics and the research approach of Innovation Biographies provide a relevant complementary perspective to the body of research. Due to the micro-level and process-orientation (cp. chapter 3), the evolvement of an innovation process from its origins until its implementation, its actor constellations, and the related interactions, are at centre. This not only sheds light on the interdependencies between patenting, networks, learning, relations, etc. and it can be studied how these co-evolve. Furthermore, spatial reach of knowledge dynamics is

assessed and put in relation to the actors from which knowledge originates. How this will be operationalised in the course of this dissertation will be outlined in the following chapter.

CHAPTER 3

3.1 Further Course of the Dissertation

Analyses and discussions of results obtained in this dissertation are organised in a cumulative format, i.e. the three subsequent chapters have been published in, or are submitted to scientific journals as separate research articles. All chapters will be summarised in the following.

Chapter 1 introduced the research questions, subject matter and aims of this dissertation. This was followed by a synthesis of key argumentations of recent debates on the spatiality of knowledge in innovation and the elaboration of open research issues in chapter 2. Chapter 3, i.e. this chapter, elaborates the further course of the dissertation.

Chapter 4 entitled *"Exploring Territorial Knowledge Dynamics with Innovation Biographies"* discusses the research approach of Innovation Biographies in detail. Accordingly, chapter 4 starts out with outlining prominent empirical approaches in economic geography. The chapter then introduces three conceptual building blocks in which key considerations of Innovation Biographies are discussed. The building blocks are "A Knowledge-centred View Based on the Micro-level", "The Open Exploration of Social Networks and their Evolution", and "A Biographical Time-space Perspective on Knowledge Generation".

This discussion is followed by a detailed account of the research procedure of innovation biographies, consisting of a narrative interview, network analysis, subsequent interviews and time-space paths. The next part of the chapter presents an Innovation Biography case study to illustrate the procedure and nature of results. It explicates how different knowledge is combined over time, the variety of channels through which it is exchanged, and the respective time-spatial dynamics of an innovation process. The chapter concludes with a discussion of the value-added of the Innovation Biography approach, and reflects its advantages and drawbacks.

Chapter 5, entitled *"The Nature of Knowledge Generation and Application in Tourism Innovation"*, commences with a discussion on knowledge in tourism innovation and subsequently analyses nine Innovation Biographies carried out in the tourism sector. In particular, questions such as "What kind of knowledge is developed and applied in the innovation process?"; "What actors take part in the development of an innovation?"; and "Which locations do they come from?"; are addressed. These questions are discussed by an in-depth analysis of an innovation process and by complementary quantitative comparisons of Northern European and Turkish innovation cases, likewise obtained with Innovation Biographies.

Results of the study show how the innovations have been developed based on various knowledge types including research, design, implementation, and marketing related knowledge. Furthermore, the respective share of public, private or semi-public actors participating in the innovation processes turned out to have implications for the geographical pattern of knowledge dynamics. Sources from which knowledge originates tend to be regionally bounded when the majority of actors are public and internationally spread when the majority of actors are private. These results provide insight into the innovation strategies of tourism actors. Accordingly, it is possible to differentiate between an "assimilation" strategy, in which knowledge comes from regional actors, and a "distinction" strategy, in which relevant knowledge comes from international actors.

The following chapter (chapter 6), *"The balance of change and continuity in the German construction sector's development path",* analyses how the particularly spatial, project-based structure of the construction sector influences knowledge dynamics in innovation processes. The analysed data is derived from seven Innovation Biographies. It is argued that a "renewal paradox" exists in the sector. The renewal paradox arises due to a continuously high degree of novelty generated in each construction project on the one hand; and a low storage-capacity of knowledge and innovations (in particular of organisational innovation) caused by the project-based structure, on the other.

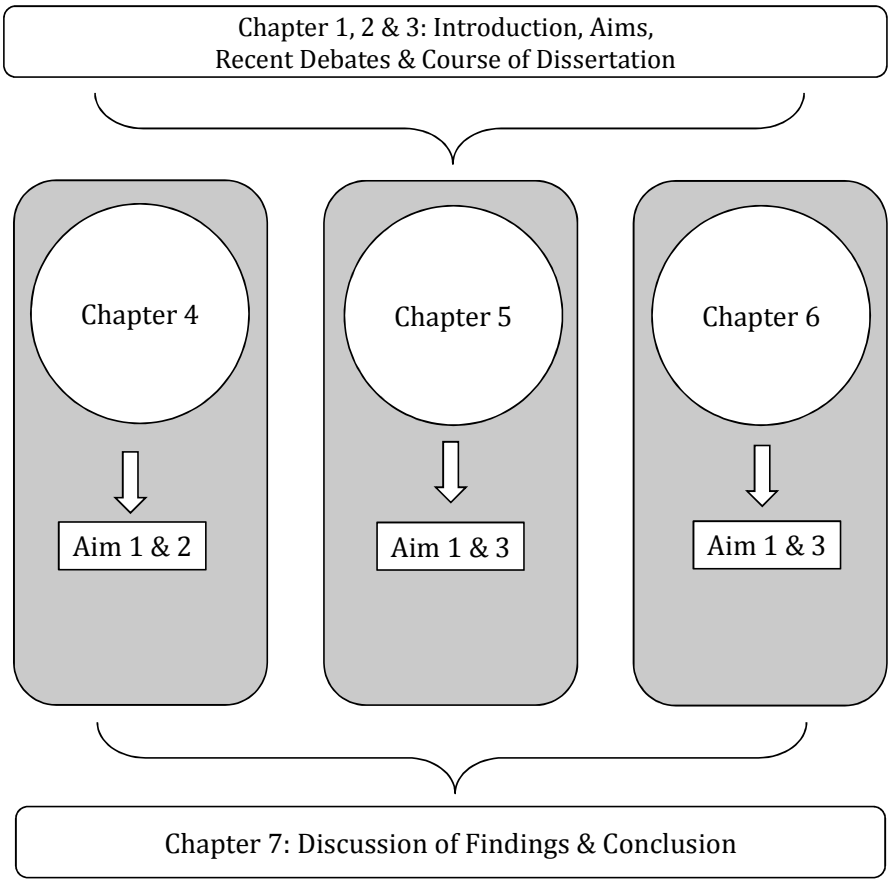
Current innovations aim at overcoming negative effects of the project-based structure. The innovations are considerably influenced through combinations

of knowledge from different sectors and from different parts of the construction sector's value chain. A typology is constructed out of the seven Innovation Biographies, consisting of types labelled "enhancing technical capabilities", "prefabrication", and "expansion of competences/overcoming communication problems". It is shown in how far the types impact on the sectors development path and how they are based upon knowledge combinations.

Chapter 7 synthesises the findings of the earlier chapters (3-6) and discusses the contributions of this thesis with regard to the developed aims. Furthermore, it formulates policy implications and future research issues.

According to the structure of chapters, the flow and interdependencies of this dissertation are as follows. In chapter 1 & 2, research questions, aims and recent debates have been introduced and discussed. The course of the dissertation has been introduced in chapter 3. Chapter 4 addresses the first and second aim of this dissertation, the chapters 5 and 6 underpin the first and the third aim. Findings are synthesised in the concluding chapter (chapter 7). The flow of dissertation is illustrated in the following figure (cp. figure 2).

Figure 2: Flow of Dissertation



Source: own illustration

CHAPTER 4

Exploring Territorial Knowledge Dynamics with Innovation Biographies

4.1 Introduction[10]

There is a continuous debate in regional studies about the adequateness and transparency of research design as a prerequisite for sound interpretation of findings, claims and conceptualisations (Markusen 1999; Hudson 2003; Peck 2003; Lagendijk 2003). Despite controversies characterising the debate, there is agreement that ill-defined, diffuse research designs lead to "fuzzy concepts" (Markusen 1999) that can be interpreted in more than one way and thus lack explanatory power.

Against this background, in a special issue that claims a shift from Territorial Innovation Models (TIMs) to the concept of Territorial Knowledge Dynamics (TKDs), a discussion on research design would be good practice and accordingly should have its place. This even more holds true in the case of the research approach of "Innovation Biographies" (Butzin et al. 2012), that contains novel combinations of methods and has been the pertinent research design[11] to study crucial characteristics of TKDs. This paper aims to make the research procedure of Innovation Biographies transparent, to discuss the value-added and respective reach of results of the approach, and therewith contribute to the conceptual clarity of TKDs.

When designing the research process of Innovation Biographies, recent dynamics in economic action that are also conceptualised in TKDs have been

[10] The paper is currently under review in Regional Studies and supposed to be part of a special issue on "Territorial Knowledge Dynamics" edited by Jeannerat, H. and Crevoisier, O. (authors: Anna Butzin and Brigitta Widmaier). An earlier version is published in the Working paper series on innovation and space, no. 07/12, Department of Geography, Philipps-University Marburg (Butzin and Widmaier 2012).

[11] Research has been undertaken within the frame of the project EURODITE – Regional Trajectories to the Knowledge Economy, funded within the FP6 programme of the European Commission (CONTRACT No. 006187)

the starting points. These dynamics firstly, refer to the growing mobility and multi-locality of knowledge around the globe and the increased pressure for regions and firms to integrate knowledge from distant locations and from different sectors (Crevoisier and Jeannerat 2009). Secondly, to the re-organisation of economic activities that is heavily influencing the nature of innovations. Examples are the growth of knowledge intensive services taking over R&D functions (Strambach 2008), cross-sector innovations, as well as the influences of customers on product design and demand (Grabher et al. 2008). Thirdly, apart from techno-scientific knowledge in innovation, socio-cultural forms of knowledge are ascribed to be of equal importance. They more and more complement the still dominant analytic (science-based) and synthetic (engineering-based) knowledge bases by symbolic (art-based) knowledge focussing on design, advertisement and image creation (Asheim et al. 2011).

Taking into account these recent changes, questions concerning the use of knowledge in concrete innovation processes become more pressing: How do knowledge generation and application in innovation take place in light of different geographical scales from which knowledge can originate? How does knowledge evolve over time in innovation processes? What are the social processes and related interactions, especially against diversified actor types that might participate in innovation processes? Which conditions (institutional, social, economic, political, spatial) are shaping these social processes and related interactions?

Apart from conceptual renewal expressed in TKDs, another consequence to be drawn from current economic change and upcoming research questions is the adaptation of research approaches to retrieve empirical evidence. In particular, this can be achieved by enlarging the scope of data generation towards multi-scalar interrelations, cross-sector cooperation, and knowledge as the central research objects. Innovation Biographies have been designed to include these. In order to do so, they take an innovation itself as the organising principle of research. The key idea is to examine the dynamic nature of knowledge during a concrete innovation process from its first idea until its implementation and to disclose how knowledge is moved through time and space.

4.2 From the Regional Scale to Multi-Scalar Knowledge Flows: Concepts and Research Design

The research design of Innovation Biographies is constituted of building blocks and instruments. It is derived from translating findings and methodological considerations, as well as from the claim to minimize some of the remaining research gaps, of established research fields in regional studies into a methodological set-up. The research fields are territorial innovation models (TIMs) (Moulaert and Sekia 2003) and their mixed-method approaches; the proximity debate (Boschma 2005) and the fast co-evolving interest in social network analysis from a dynamic evolutionary perspective (Balland et al. 2013); and the multi-scalar view on economic action as proposed in the Global Value Chain and Global Production Network (GVC/GPN) approaches (Coe et al. 2008). Furthermore, the research design is informed by the routes of recent economic change, namely the growing mobility of knowledge, the re-organisation of innovation activities, and the importance of various forms of knowledge. How these various influences have been operationalized in Innovation Biographies will be recapitulated in the following.

For quite some time a central topic in exploring the sources for regional economic development has been to study the relationship of innovation and space through TIMs (Simmie 2005). Taking geographical proximity as a starting point, the central question was how regional actors of all kinds (public, private, and intermediary) interact, apply and share knowledge as well as which factors would favour or hinder their cooperation. From the research on TIMs we know of innovation as a spatial and knowledge-intensive learning process that is generated through the interaction of different actors (Moulaert and Sekia 2003).

Major empirical approaches applied for studying TIMs, especially in case of regional innovation systems as the most widely adapted TIM, is analysing the regional economic structure through industry classifications and employment statistics, the distribution of firm size, research facilities and R&D intensity, as well as the education system (cp. the case studies in the book edited by Braczyk et al. 1998). This is backed up with surveys to addressing cooperation intensity among regional actors (Tödtling et al. 2011), and with

conducting structured or semi-structured expert interviews and workshops with regional triple-helix actors to enforce technology transfer, networking and university-industry links (Cooke and Kaiser 2012). Results provided strong accounts of regional economic activity and its relation to the socio-cultural and institutional context. However, most often analyses provided a rather static picture of the current status-quo without accounting for regional economic change (Lagendijk 2003). Furthermore, minor attention was paid on the influence of extra-regional relations (Oinas and Malecki 2002).

Based upon the proximity debate, the view on innovation has been broadened. Apart from geographical proximity, other dimensions of proximity are assumed to be a necessary prerequisite to make learning and innovation successful (Boschma 2005; Rallet and Torre 2005). This has raised the quest for a network (or relational) approach with the aim of concretising the configuration of innovation networks that can well reach beyond the regional level. Through social network analysis of large available data bases, such as the co-inventor network in the German biotechnology industry measured as of applied co-patents (Ter Wal 2013), or project networks funded by the European Commission, a more diversified picture of relations and proximity dimensions in innovation has been empirically tested (Balland 2012).

The obvious advantage of applying social network analysis is grasping the collective mechanisms of innovation generation (Giuliani 2011: 160) through "macroscopic mapping" of links within a territory (Krätke 2010: 86; Ter Wal and Boschma 2009). The drawback is the prominence given to the structure of relationships while concretisation of the embeddness of economic behaviour (i.e. characteristics of social actors, the content of ties and the institutional background) remain underdeveloped (Giuliani 2011: 162; Krätke 2010: 86).

In contrast to this partly structuralist approach, studying the embeddness of economic actions is the central concern of GVC/GPN school of thought. Within this body of research, post-structuralist qualitative forms of enquiry such as ethnographic studies and explorative network analyses in the sense of Latour (1987), i.e. to follow innovative actors, are much more prominent. For example, studies have been applied in research on the geography of food,

where "the organizing principle for research could be specific foods and ingredients, simple or complex". Therefore, food geographers "get inside [the] networks, go with the flows and look to connect" (Cook 2006: 657; with reference to Crang 2005: 49).

As much as food products or other goods, innovations can be studied from this perspective. Therefore, Bunnel and Coe as proponents of the GVC/GPN approach claim an analysis of innovation by "exploring the linkages and interrelationships between and across various spatial levels or scales, from the 'regional/local' through to the 'global'" (2001: 577). Behind this multi-scalar view lies the notion that the environment of innovations is characterised by a continuous and dynamic flux of knowledge and technological change that permanently transcends regional-administrative and sectoral boundaries (cp. also Oinas and Malecki 2002). This argument is the starting point of the recent debate on knowledge dynamics, which has informed the Innovation Biography approach.

Despite an extensive and diverse body of literature on innovation and space, of which only a small part could be reflected above, knowledge as a key resource of innovation processes has not explicitly been a central research object of spatial innovation research for a long time (Howells 2012). And, although we have substantive knowledge about important context determinants (as an outcome of the TIM literature) and characteristics of network structures through which knowledge is exchanged (cp. proximity debate), the open question about the concrete nature of knowledge flows remains (cp. also Krätke 2010: 85).

The resulting research gap is about to be closed, since concretising the dynamics of knowledge and learning in innovation develop into a more prominent field of research (e.g. Asheim et al. 2011; Strambach and Klement 2012; Plum and Hassink 2013; Butzin and Rehfeld 2013). There is interest in finding out how knowledge can be further qualified, how it is developed over time, where knowledge comes from, and how actors from various levels cooperate with each other to bring about innovative developments.

The TKD concept (Crevoisier and Jeannerat 2009) takes this issue as a starting point. TKDs are understood as a dense knowledge-space bringing about novelty through the combination of knowledge from different places and from different domains. In a world of endless possibilities of knowledge generation and combination, and knowledge sources placed around the globe, a key feature is the ability to mobilise well-suited knowledge independently from its sectoral or geographical origin and to anchor it within the regional context.

The underlying intention is setting apart from the paradigm of cumulative knowledge generation as argued for within the TIM literature, where innovation was supposed to be determined by building upon the existing stock of regional knowledge with the consequence of strong (or even over-) specialisation. Instead, combinatorial knowledge dynamics as a new paradigm describing modes of production and innovation development imply diversification, cross-sectoral knowledge exchange and a global reach (Crevoisier and Jeannerat 2009) as also emphasised in the GVC/GPN approach.

Innovation Biographies have been the magnifier shedding light on the micro dynamics of TKDs. Results obtained provided powerful explanations that furthered the TKD concept, in particular with respect to the concretization of combinatorial knowledge dynamics, their global stretch-out and related actor constellations.

Innovation biographies base upon three interrelated conceptual building blocks that were seedbed for designing the concrete research procedure and for selecting research instruments. They include focus on knowledge dynamics, an open exploration of social network evolution, as well as a biographical time-space perspective on innovation development (Butzin and Widmaier 2012).

4.2.1 Building Block 1: A Knowledge-Centred View Based on the Micro-Level

Krugman`s well-known citation says “knowledge flows ... are invisible, they leave no paper trail by which they may be measured and tracked” (1991: 53).

This might be a true observation when looking for hints of knowledge flows on paper with the idea of a clear quantitative measurement (though it has been challenged by scholars conducting patent analyses, cp. Audretsch and Feldman 2004). However, it is argued that knowledge in fact must leave a trail even if not (fully) documented on paper. This trail takes shape in the biographies of innovations – and it can be replicated verbally by the people who have been involved in it.

Innovation Biographies aim at analysing knowledge flows in innovation processes across time, space and individuals. Knowledge flows and related dynamics are understood as evolving in a flow of distinct innovative actions that cause movement, transformation and creation of knowledge (Strambach 2008). Concrete innovations at the micro-level are regarded as the entry point to the world of knowledge dynamics. By re-constructing the biography of an innovation process, knowledge dynamics are grasped at their origin.

Having the starting point at the micro-level implies a shift in focus which has not been done quite often in economic geography, since it does not "end at the factory gate" as Maskell (2001: 330) once critically described the majority of economic geography research. (Of course there exist exceptions, e.g. Amin and Cohendet 2005.) Innovation Biographies step inside the factory gate to understand how internal knowledge is related to the various sources of external knowledge coming from multiple scales and how this evolves over time.

4.2.2 Building Block 2: Open Exploration of Social Networks and their Evolution

With their scope (i.e. knowledge, social processes, related context), the research questions guiding innovation biographies can only be addressed by methodologies allowing in-depth longitudinal qualitative analyses (cp. also Crang 2002). In particular, this is achieved by conducting a central narrative interview with a person who had major responsibility for an innovation project. This person is asked to tell the innovation story from the first idea until its implementation. One important component of the interview is to explore

the evolution of the actor network, how it co-evolved with the further development of the innovation process, and from which locations (from local to global) the actors originated. By qualifying the interrelationships of the network, i.e. through knowing the reasons *why* actors have been selected, *how* they have been searched for, *how* cooperation was established, *what* kind of input has been provided and *whether* there might have been conflicts, etc., in-depth insights into innovation processes are obtained. Thereby, the time-perspective is crucially relevant for grasping the dynamics of the diverse constellations.

The combination of the ground-level perspective of Innovation Biographies, alongside the tracing of the social network and its context, allows connecting Innovation Biographies to two different schools of thought. These are actor-network (Latour 1987) and grounded theory thinking (Glaser and Strauss 1967). The constellation of empirical instruments in innovation biographies is designed in a way that allows following the innovating actors and their embedding in the evolving network. Through tracing the network of actors, the reciprocate influence of social relations and innovation development can be grasped. The connection to grounded theory is installed through the narrative interview and the open, inductive research procedure. Inductive data analysis has the potential to explore phenomena disentangled and uninfluenced from existing concepts or methods (e.g. inductive analysis of Innovation Biographies has substantially informed the TKD model).

Furthermore, Innovation Biographies can be aligned to Yeung's (2003) "new economic geographies". The main objective of new economic geographies is to understand the social embeddedness of economic actions by treating economic, social and cultural behaviour as an equal triad also regarding methods (which mostly tend to emphasise the triad's first notion). Yeung argues for a process-based methodological framework that is characterised through tracing actor networks as a contrast to the collection of large scale databases: "New economic geographers, however, afford much more validity and reflexivity to tracing networks, as a key research practice for understanding the territorial constitution and reshaping of economic organisations via their engagement with an array of actor networks" (Yeung 2003: 449). Such an approach is mirrored in Innovation Biographies.

One lever to trace actor networks is to follow them from a biographical time-space perspective, which has been established in the third conceptual building block of Innovation Biographies.

4.2.3 Building Block 3: A Biographical Time-Space Perspective on Knowledge Generation

A time-related view allows *following* the process of learning and development. It puts focus on the evolution of dynamics and on the question how knowledge interrelates, was built upon each other and thus, constituted the biography of innovations.

By studying knowledge dynamics and the related actor network, and combining both with the geographical dimension, their time-space path[12] and micro geography becomes visible (an illustration is provided in the case study presented in this paper). A time-space path is known as an element of time geography (Hägerstrand 1967, 1987) where it is utilized as a practical tool to measure and visualise movement in time-space. In Innovation Biographies the time-space path illustrates the interrelations among multiple scales within the creation of knowledge and the parallel evolution of networks.

A time-related view has also been applied in other disciplines studying innovation. Within the field of science and technology studies, Rammert (2000) has explicitly claimed to study the biographies of innovations as the essential small scale developments constituting 'Technikgenese'. In the same discipline, Van de Ven et al. have undertaken 'Innovation Journeys', and followed innovation processes over time to develop a process theory of innovation (Van De Ven et al. 1999). More generally concerned about the evolution of industries, Bruns et al. (2009) analysed the innovation biography German wind energy sector, or Kash and Auger (2005) the diffusion process of the Bosch diesel fuel injection systems from 1922 onwards.

[12] The aspect of time-space paths of Innovation Biographies has been developed together with Dr. Anders Larsson, department of human geography, University of Gothenburg.

Biographical research has also found its entrance into economic geography, though it has no prominent position. For example, Vinodrai (2006) followed career paths of designers based in Toronto to show high circulation of talent and related knowledge flows in the local design sector. Another example is Törnqvist (2004), who has illustrated biographies of Nobel laureates with time-geography diagrams to examine the importance of innovative places for the careers of individuals. Being more product oriented, Ibert (2010) compiled the ethnography of an analytical device to study socio-cultural and time-spatial tensions in innovation practices, and food geographers for instance, have studied the globalisation processes of local foods (e.g. tortillas, sushi) (Bestor 2005; Gabel and Boller 2003). In this context, they have explicitly drawn the connection of biography and geography (Cook et al. 1998).

What is new in Innovation Biographies as outlined in this paper is the layering of time, geographical data and micro-level knowledge flows. Together these components constitute a research program through which the social mechanisms of knowledge dynamics, their spatial unfolding and their eventual convergence into an innovation can be grasped. How the research process of innovation biographies works in detail will be presented in the following.

4.3 Research Process of Innovation Biographies

A mix of methods transforms the above ideas as expressed in the research questions and the three building blocks into a manageable research process (Butzin 2012a). Insight into the time-space dimension is obtained through tools of biographical research (Roberts 2002). The overall aim of biographical research is to explain broader-level societal structures based on insight derived from the micro-level, i.e. to uncover regularities from the study of particular small-scale developments (Chamberlayne et al. 2000). This claim can also be assigned to innovation biographies. It is operationalised by following the life-story of an innovation through a major narrative with the key responsible person and subsequent interviews with the other main actors of the innovation process. Ego-centred network analysis (Wassermann and Faust 1994) was chosen to explore the evolution of the actor network, their

location and content of interaction (the innovation is considered the ego, as will be explained later on). Triangulation (Rothbauer 2008; Flick 2011) and mapping of the time-space path are means to combine the diverse data, as only their ensemble as a whole constitutes the Innovation Biography.

4.3.1 Preparation and Narrative Interview

There are three ways of starting the research process. Either an innovation is known from the beginning as being a promising candidate for an innovation biography, or a certain firm or organisation is chosen which is assumed to have carried out an interesting innovation, or key informants (industry experts, etc.) recommend critical cases. Selecting the case as well as the definition of what is considered innovative is connected to the research context in which the Innovation Biography is carried out. Experience of field work has shown that Innovation Biographies are equally applicable on organisational, process, product, service or social innovations and – not unimportantly – also in the case of failed innovation processes.

Intensive desk research about the firm or organisation, its main products, history, number of employees, etc. should be part of the preparation for the narrative and for the interviews following the narrative. This will provide relevant background information and facilitate the communication with the interviewees. Moreover, innovative products might be advertised on the homepage or in press articles and could be pre-selected.

The backbone of an Innovation Biography is the narrative interview with the major responsible person of the innovation process. It is the essential instrument of operationalising the open/explorative approach of Innovation Biographies. The overall aim is to get in-depth insight into the entire process of knowledge creation from its beginning until its implementation and to have a first version of the biography. To start the narrative, the interview partner is motivated by an initial question that stimulates a free reflection of experiences in a continuous flow of words. To achieve this, the question needs to contain a clear starting point and an end (Jovchelovitch and Bauer 2000). A clear starting point is established by asking for the situation in

which the first idea of the innovation arose. Flow of words is maintained by providing a straightforward 'narration corridor' by asking for the involved actors, the time-line, the milestones and barriers of the innovation processes. The conclusion relates to means of implementation or market introduction. More detailed questions at the end of the narrative should aim at concretizing important aspects, for instance actors involved or the time-line of the biography, that have not yet been described clear enough by the interviewee.

It should not be unnoticed that quality and quantity of narrative information heavily depend on the narrator's ability and willingness to speak about the innovation process. In some cases the responsible persons simply do not want or cannot talk about the innovation process, because they have to protect intellectual property or the R&D partners of the firm. Furthermore, even a well-expressed detailed story may leave aside problematic periods, put certain actions in an inadequately positive light or vice versa, or may not mention major failure during the process (cp. Miles and Crush 1993 for a discussion of advantages and drawbacks of narratives). Partly, this can be balanced out by subsequent interviews carried out with other actors of the process as they might see things from a different perspective. However, a residual risk of getting inexact information will remain.

Provided that the narrative was successful in terms of getting sufficient information about the innovation process, a first version of a biographical text is developed that includes the time-line or sequence of events, involved actors, their geographical locations and the development progress.

4.3.2 Ego-Centred Network Analysis and Further Interviews

Based on this information, subsequent desk research aims at identifying the actor network around the innovation. Generally speaking, in ego-centred network analysis which is applied here, a network is described via one node (ego), usually an organisation or a person and its relationship to other persons or organisations (Wassermann and Faust 1994). Egocentric network analysis only asks for the relations of one ego to different alters, but does not analyse the entire network (Jansen 1999). In Innovation Biographies, the

node is neither a person nor an organisation but the concrete innovation itself.

In the first instance, the egocentric network analysis shall shed light on the actors that have taken part in the development. Concretely, this means analysing modes and frequency of the interaction among the main responsible and externals, the type of exchanged knowledge, the sectoral affiliation etc. To better understand the evolvement of knowledge dynamics, it is of significance to know at what point in time a particular actor has got involved in the process, where his/her organisation or firm is located or when other events (e.g. newly set-up political regulations) have set knowledge dynamics in motion. This enables to analyse the impulses affecting them, how they build upon each other, cause feedback loops or might even require a radical change in the direction of development.

Ego-centred network analysis is always selective (i.e. it is seen from the perspective of the "story teller") and covers only a particular part of a more complex and multiple network (Gerich and Lehner 2003). But its advantage is a straightforward access to the composition of actors, information on a considerably detailed level, and a direct evaluation of the influence actors have on the innovation process.

The ego-network is then combined with geographical and time data. In so doing, every link of the innovation biography is qualified with its territorial dimension and the spatial pattern of the innovation process can be visualised (cp. figure 3).

The ego-network is also crucial for finding the next interview partners. This should be other persons who had decisive functions in the innovation process from inside the organisation or from other externally involved actors. In a narrative, semi-structured or structured way – depending on the quality of information obtained in the first interview – the first aim of these subsequent interviews is to enrich the biographical picture developed through the information of the first interview and implicitly have verified the information gathered. The second aim is to be led to next interview partners (via snowball sampling) and again these can come from the same organisation or from

other, externally involved actors. The same interviewing procedure is then applied in the following interviews so that the body of biographical material extents with the number of interviews. It is surely not possible or necessary to speak with every actor involved in the innovation process. What is important is to get a full picture of the main actors, what they have contributed in terms of expertise and competence, when they entered the development process and where they were located.

4.3.3 Triangulation: Building the Biography and Analysis

To make the biography accessible for analysis, the concluding step is to triangulate data of the various interviews, the ego-centred and geographical analysis, and of the desk research into a coherent story. The ensemble of data sources eventually constitutes the Innovation Biography. Triangulation means applying different empirical methods to one object of study, which in this case is the innovation process (Flick 2011). To achieve maximum output, an optimal triangulation procedure contains data acquisition on different levels (cp. Fielding and Fielding 1986; Flick 2011). In the case of Innovation Biographies, the various interviews constitute an individual level by letting the actors express their view. Data on the structural level, i.e. the involved actors, modes, frequency and geographical spread of interaction, was obtained with the ego-centred network analysis and the construction of the time-space path. Document analysis as a third component, has the function to enrich the biography by understanding sectoral specifics and the contextual level.

Based upon data triangulation, writing and analysing an Innovation Biography is a process of telling a real, detailed and "thick" story covering all relevant aspects. These are the contextual settings and impulses through which the innovative idea arose for the first time; how the idea was further developed, the emergence and change of actor constellations over time, the question how this has influenced the innovation process, and through which channels they have got in contact with each other, etc.

This coherent and multi-facetted case-study is a meaningful result in itself showing the complexity of knowledge in innovation. A thick description of what was selected as a "critical case" is rich of information and has "greatest impact on the development of knowledge" (Patton 2002: 236). Vissers and Dankbaar (2012) for example, have analysed a critical case with Innovation Biographies, namely the development of the AFLP technology (amplified fragment length polymorphism) that was decisive for the growth of Keygene, currently being the largest green biotechnology company in The Netherlands. In the biography, they disclosed social interrelations, other contextual determinants such as shareholdings, intellectual property rights, patents, and the developments on the US biotechnology market and showed how this had decisive influence on innovation development and company growth. Thereby, the reader gets exceptionally holistic insights into innovation behaviour and its mechanisms in green biotechnology that not at all could have been provided by narrow analyses of patents, licences, or inter-firm networks.

Taking the innovation story as basic data there are, however, further approaches to analyse results. These are focused analyses of specific aspects (e.g. combinatorial knowledge dynamics in innovation processes), comparative case analysis and the construction of typologies (Butzin and Rehfeld 2013), or quantitative analyses of the content of social relations in innovation biographies (Strambach and Klement 2012). In the following, an Innovation Biography selected as a critical case for explicating the variety of knowledge combinations in innovation will, due to space limitations, be presented in a focused manner.

4.4 The Intricate Innovation Biography of a Flexible Ceramic Wallpaper Developed in a Nanotechnology Firm

The flexible ceramic wallpaper[13] was developed in the R&D unit of a multinational chemical company based in Germany. Data acquisition of the Innovation Biography is based on a series of interviews with major actors of the in-

[13] A much earlier version of this case is presented in Butzin 2009. Meanwhile, the innovation process was furthered by the actors involved. Therefore, more interviews and analysis of additional partners have been carried out by the author, which are studied in this article.

novation process and an intensive document analysis (press releases, commercials, industry reports, etc.). The first narrative interview was given by the head of company. The second interview was held with the project manager. He explained the evolvement of the development process, including problems and barriers, and the constellation of internal and external actors. Based on this information it was possible to analyse the innovation's ego-network of partners. It resulted in the acquisition of subsequent interviews.

Developing the wallpaper was an intricate process. It started with serious internal discussions about the appropriateness of realising the idea, since the wallpaper did not match the product portfolio of the firm. Furthermore, the case is characterized by four decisive phases of knowledge combinations, which were difficult to manage. The science-based nanotechnology related knowledge existing within the firm needed to be combined with knowledge from engineering and the film industry, from painters, from creative industries, and from a supplier company of the construction industry. In terms of different geographical scales, the innovation process starts on company-level where idea and prototype were developed and then pro-actively stretches out on national and international level (cp. figure 3).

The key innovative moment of the wallpaper is its surface material, i.e. the flexible ceramic that combined the advantages of tiles (waterproof, fireproof, dirt-repellent) and conventional wallpaper (quick application, broad range of designs). The idea to develop it arose due to the wish of better utilising knowledge on flexible ceramics existing from previous research on lithium ion batteries for electric motors.

A first prototype of the wallpaper was developed strictly in-house. This was to protect knowledge about flexible ceramics as strongly as possible, because of its potential for new battery technologies. The prototype was then presented on a fair. The presentation was a lever to get new knowledge inputs through testing the reaction of market actors and other professionals.

4.4.1 Nanotech, Engineering and the Film Industry

Positive feedback stimulated the construction of a production plant in the company's technical school. Because of limited in-house competences, construction was done in cooperation with an engineering company.

It turned out that first test series had uneven margins. This was a serious problem, because unlike ordinary wallpaper, ceramic wallpaper cannot be pushed to butt at the edges. Additionally, the water-resistance could no longer be maintained. Internal knowledge development to find a quick solution aimed at improving the material and to modify the production plant. However, it was an unsuccessful process of trial and error that resulted in increased pressure for acquiring help from external sources.

An intensive, though cautious (no one wanted the problem to become too public) search process began. It widely transcended sectoral boarders since eventually, relevant expertise was found in the film industry where the production process of film spools needed to be perfectly accurate to ensure their smooth roll up. (Surely the digitalization has changed production processes today.) Because of the high similarity of demands between producing the flexible ceramic wallpaper and film spools, the knowledge input from the film company was essential to furthering the innovation process.

4.4.2 Nanotech and Painters

Modified production was a milestone in the innovation process and disclosed further disadvantages concerning the installation of the ceramic wallpaper. Intensive cooperation with painters was initiated to improve the installation properties: A painter was hired in order to install different versions of the wallpaper and to test its functional properties within the company buildings. This enabled immediate feedback and interaction between technological and applied know-how. Other painters were invited to a series of laboratories in which the ceramic wallpaper was presented, applied and in which feedback was given.

4.4.3 Nanotech and Creative Industries

One advice from the workshops was to improve the wallpaper's look since the scientists had more focused on the technological properties than on the visual appearance. A freelance interior designer was contracted (the high-tech knowledge of the nanotechnology firm did not include design competences). The interior designer's task was to increase the variety of colours, surface structures and collections. With this employment the so far technically and functionally oriented innovation process reached a stage in which symbolic knowledge attributes, i.e. design, appearance and emotional features, became central. At about the same time, first contacts to international trades specialised in supplying wall covering products have been established to get access to relevant knowledge concerning distribution and to build up a dedicated network. Furthermore, first lead customers (especially hospitals and kindergartens) have been acquired. Beyond that, other commercialisation activities were once again taken over by external actors' competences. Commercialisation was assigned to an agency specialized in bringing high-technology innovations to end-consumer markets. The reward of several design prices for the flexible ceramic wallpaper leads back to the engagement of this agency.

4.4.4 Nanotech and Construction Industry

Though originally planned differently, today, production and distribution of the ceramic wallpaper is completely out-licensed to a construction company trading with wallpapers and other wall-covering products. Obviously, only the development of the ceramic wallpaper was successful, whereas implementing its production and distribution facilities was a too ambitious project for a research-based nanotechnology company, which did not pay out in the end. The case of the flexible ceramic wallpaper not only shows how and why diverse knowledge is combined in innovation processes. It is also an indication for the limitations of knowledge combinations that in this case resulted in a product being too far away from the company's core competences. The time space-path of the Innovation Biography illustrates the knowledge combinations and related time-spatial developments (cp. figure 3).

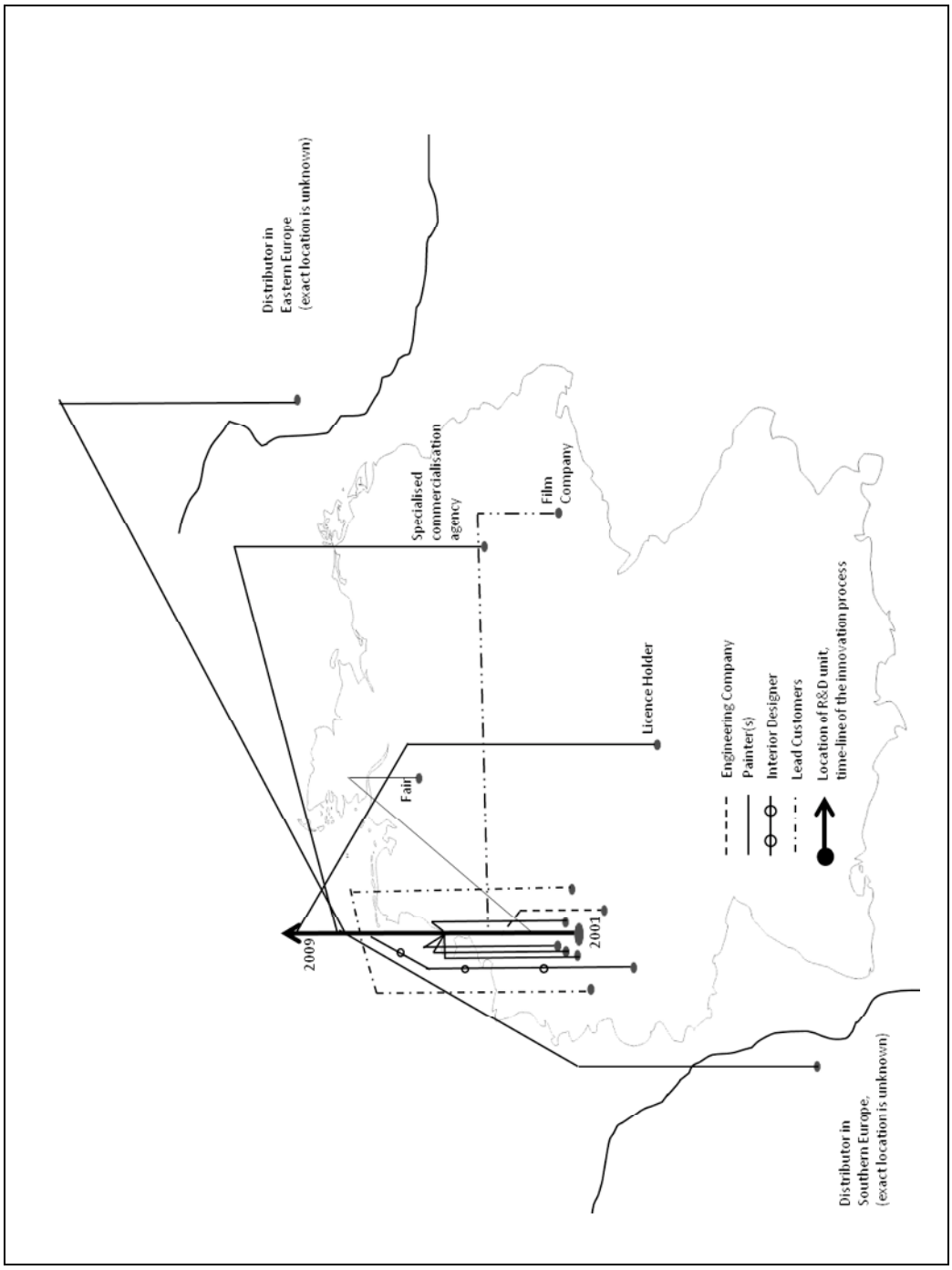


Figure 3: Territorial knowledge dynamics in time and space

Source: own illustration, data based on interviews

4.5 Discussion and Conclusions

Innovation Biographies allow a holistic and detailed approach to the analysis of territorial knowledge dynamics. Their key methodological principle is to follow the innovation idea by analysing the interactions of innovation actors and by applying a grounded theory approach to data analysis. This open approach, enabling explorative, multi-scalar research on concrete innovation cases, is the essential distinction of Innovation Biographies compared to methodologies of other research fields in regional studies, as summarised in table 2.

Through the process perspective, conducting and analysing Innovation Biographies provides substantially enriched insight into knowledge creation, its dynamics and spatial patterns in innovation. In particular, Innovation Biographies give answers about *why* actors cooperated. They go far beyond the often applied horizontal and static analysis of cooperation structures combined with the geographical location of actors. Thus, analysis of Innovation Biographies provides explanations of the *causalities* of innovation creation. In other words, they show the interdependencies of an innovation's development path of knowledge generation.

Understanding the causalities of innovation processes gives insight on how knowledge from various sources is combined during the innovation process. In the case of the flexible ceramic wallpaper, a diversity of knowledge from scientists, creative, crafters, and actors of the building industry was combined and communicated through equally diverse channels (from very open ones in which knowledge could flow without restrictions, i.e. fairs, workshops, to those limited by disclosure agreements and patent protections). This also has policy implications, since it challenges the widely practiced geographically and sectorally bounded funding structures of supporting innovative developments.

To conclude, the major advantages and drawbacks of Innovation Biographies will be recapitulated in the following. Advantages are:

Firstly, through the *process perspective*, Innovation Biographies provide detailed accounts of the dynamics of knowledge generation in innovation development. Innovation Biographies not only focus on content and social constellations, but also on the latter multi-scalar scope and evolution over time. They disclose the causalities and interdependencies of knowledge creation in innovation processes.

Secondly, Innovation Biographies follow concrete innovation events at the *micro-level*. This is the actual level of innovative action within firms, networks, project teams, non-profit organisations, etc. It can be assessed how firm-internal knowledge is related to the various sources of external knowledge. Thereby new insight into inter-firm relations is provided.

Thirdly, the scope of Innovation Biographies is not limited through predefined categories, be they administrative areas, industry classifications, technological fields of patent statistics, etc. Innovation biographies enable to analyse *cross-sectoral relations* emerging on *multiple territorial scales*.

Fourthly, Innovation Biographies are constituted by a *standardised set of research instruments* (narrative, interviews, ego-centred network analysis, and triangulation) that allows for comparative research without bias caused by use of different instruments. This allows to apply Innovation Biographies across different research teams and to compare findings.

Table 2: Innovation Biographies and Research Approaches in Regional Studies

Approaches / *Research...*	*Territorial knowledge dynamics: Innovation Biographies*	*Proximity debate: Social Network Analysis*	*TIM research: Mixed Method approach*	*GCC/GPN: Ethnographies, mixed methods*
...question (general)	What is the relation of knowledge dynamics, social processes and context determinants in multi-scalar innovation processes?	What are the structural characteristics of social relations in economic actions?	What are factors of regional innovation generation?	What are the power relations and social interaction of global production and consumption across spatial scales?
Key methodological principle	Follow the innovation idea by cooperating with innovation actors, process-orientation, grounded theory.	Quantitative analysis of large surveys or data bases.	Descriptive analysis of regional economic data, expert interviews.	In-situ research (participant observation, narratives).
Spatial/ structural level	Multiple scales explored bottom-up through concrete cases.	Depending on reach of network, but most often at the regional level.	Regional.	Global perspective (in this context).
...results	Explanations of causalities between knowledge creation and social network constellation in innovation processes.	E.g. the influence of different proximity types, qualifying channels of knowledge spillovers, etc.	Strength and weaknesses of regional factors for innovation and economic growth.	In-depth analysis of the global connectedness of specific industries.
Advantages & limitations	Detailed approach, but not representative, restrictions to generalising results.	Representative, but analyses an isolated part of economic activity.	Strong account of regional economic activity, but minor attention paid on extra-regional relations.	Holistic approach, but extraordinary complex.

Source: own compilation

Of course, every research approach brings along limitations that need to be considered when interpreting obtained results. Apart from bottlenecks and disadvantages related to the instruments of the research procedure (e.g. the narrative's dependence of interviewed person, and the selectiveness of ego-centred analysis) discussed above, further limitations are:

Firstly, the fuzziness about the question when an innovation biography should start and when it should end? Is it really possible to grasp the beginning of an innovation idea, do the interview actors really know the diffused situation when it arose for the first time? And, is it possible to clearly say when an innovation process ends, i.e. when it has become an established routine, product or service?

Secondly, the strong reliance on interviews requires the willingness of actors to cooperate with researchers. The likeliness to do so when reflecting successful innovation cases is much higher than to explicate a story of innovation failure. Until now, a solid set of failed innovation cases obtained with Innovation Biographies is still outstanding, not at least because related interview requests have been rejected.

Thirdly, the immense difficulty to select and define critical cases. The question whether a case fulfils its purpose will only turn out after the research procedure and analysis are finalised and the generated content is evaluated against the one of other cases. In addition, to label a case as a critical case requires particular knowledge of the researcher as regards the broader features of the innovation behaviour and knowledge creation dynamics.

Fourthly, being advantage (cp. above) and drawback at the same time, the methods of the research procedure concentrate on the narrow innovation process and do not refer to broader contextual determinants. There is thus the risk to provoke an isolated view on the innovation process, without referring to sectoral and/or institutional conditions necessary for the interpretation of findings.

However, despite the limitations, Innovation Biographies offer an alternative to the often installed high levels of abstraction and to the focus on stylised

aspects of economic activity. Innovation Biographies provide relevant and explanatory insight into the realities of economic action through which we can reflect or adapt existing, and establish new conceptual and theoretical considerations, as expressed with the TKD concept.

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CHAPTER 5

The Nature of Knowledge Generation and Application in Tourism Innovation

5.1 Introduction[14]

Until now, knowledge as an economic resource in tourism is mostly discussed in the context of knowledge management at destinations (Cooper 2006; Paraskevas et al. 2013; Pyo 2005) or within tourism organizations (Hallin and Marnburg 2008; Shaw and Williams 2009). In these studies the management of knowledge is seen as an instrument for achieving greater efficiency of the work flow, for example through the visualisation and installation of complementary competences.

The nature of knowledge generation and application is less studied as concerns the *process* of innovation development. Questions such as: "What kind of knowledge is generated and applied in the innovation process?"; "What actors take part?" and "Which locations do they come from?" can rarely be answered.

This is surprising when considering the far reaching impact sound answers would bring along, as innovation-related studies of many high-tech sectors continuously underline (e.g. Gertler and Levitte 2005). Answers would not only advance basic understanding of innovation and economic renewal in the tourism sector, they would also be an important input for policy makers to setting-up supporting structures.

Therefore, it is a central intention of this study to contribute towards closing the open research issue by providing new empirical insight. It is achieved by qualitatively and quantitatively analysing the nature of knowledge generation and application in the development process of tourism innovations. Emphasis is put on three components expressed in the questions raised above:

[14] This paper is currently under review in Tourism Management (author: Anna Butzin)

the kind of applied *knowledge*, the types of *actors* that have been involved, and the *locations* from which they originate. These components are essential for innovation, as underpinned by a broad spectrum of literature reaching from the knowledge-based theory of the firm (e.g. Nonaka and Takeuchi 1995), the triple-helix concept of actor constellations (Etzkowitz and Leydesdorff 2000), to spatially oriented innovation concepts, such as clusters (Porter 1998) or regional innovation systems (Cooke 1998) – to name only a few.

To provide a detailed account on the nature of knowledge generation and application, it is differentiated between innovation processes carried out in Northern Europe where tourism is important at the regional level but has limited significance for the countries' overall economic structure, and innovation processes developed in Turkey's mass tourism destinations where the tourism sector is well established and one of the major drivers of economic development. It is hypothesised that innovation processes show significant differences regarding knowledge generation and application due to the different context variables provided by these two environments (Butzin 2012b).

5.2 Tourism Innovations from a Knowledge Perspective

As will be elaborated in the following, the characteristics of tourism innovations and products have major consequences for knowledge generation and application in the development process. The context of innovation, understood as the immediate social and spatial surrounding, is equally influential.

Tourism innovations can have a variety of shapes. They include concrete products or services (Lowe et al. 2012), new cooperation structures (Henriksen and Halkier 2009), sustainable innovations (Strambach and Surmeier 2013), etc. Knowledge generation and application in the development process of tourism innovations is a balancing act between the integration of local resources and of internationally acknowledged trends. Whereas local resources are making the innovation unique, the linking to trends make them attractive for a wide range of tourists (Pechlaner et al. 2005).

Despite the variety of shapes, most tourism innovations are intangible and require intensive interaction with tourists in order to be implemented and consumed (Hall and Williams 2008). Production and consumption evolve simultaneously (Bieger and Weinert 2006), and many tourism innovations (and tourism products more generally) cannot be stored. This leads to an unsatisfactory distinction between product and process innovation (Hall and Williams 2008: 9). Furthermore, detailed knowledge about the developed innovation needs to be maintained, even if the innovation is implemented already, since tourists need to be informed, accompanied, or served on constant basis (this is a stark contrast to product innovations of which the distribution is less knowledge intensive).

Tourism innovations must be highly visible in order to be consumed. Their key features are thus quickly noted by competitors and a high rate of innovation imitation is a specific sectoral characteristic (Weidenfeld et al. 2010, Hall and Williams 2008, Sørensen 2007, Pechlaner et al. 2005). It is difficult to protect knowledge and innovative ideas (Hjalager 2002), since they cannot be hidden in technical equipment or in the back office and rules to secure intellectual property do not apply for the vast majority of ideas in tourism (as in all service sectors). However, bonus programs of airlines and hotel chains, member-based clubs, and highly qualified personnel are mechanisms to exclude competitors and thereby safeguard the developed knowledge (Pompl and Buer 2006).

The consumption of most tourism innovations is confined to the limited spatial context of a destination, which, at the same time, is the market area of many other tourism firms (Hall and Williams 2008, Sørensen 2007). In contrast to other branches where spatial proximity of firms of the same sector is perceived as facilitating cooperation and thereby innovation (Simmie 2005), spatial proximity of tourism firms causes high rivalry. Barriers of cooperation are enforced by the unstable nature of tourism firms in terms of survival, ownership and seasonal employment (Pechlaner et al. 2005; Henriksen and Halkier 2009).

Nevertheless, the conglomerate of firms and other tourism organizations as a whole does constitute the destination. Actors within a destination are bound

together by the routes, consumption behaviour, and experiences of tourists (Hjalager 2010: 7). As an outcome of this multi-actor system, tourism innovations will always depend heavily on the destination's other features both in a positive and negative sense (i.e. be limited and stimulated by other features) (Sørensen 2007, Flagestadt 2006). They can also be the initiator of change within the structures and routines of a destination system (Lowe et al. 2012). There is thus a considerable systemic element in tourism innovation (Halkier and Therkelsen 2013).

Through the high interaction intensity and localised components, tourism innovation can be understood as being based upon the doing-using-interacting (DUI) mode of innovation (Jensen et al. 2007). In the DUI-mode of innovation, knowledge creation takes place through informal learning processes, practitioner-based interactions, trying and testing. The DUI-mode is complementary to the science, technology and innovation (STI)-mode of innovation which is based on scientific and technical knowledge. This knowledge is much more codified, i.e. usually it is possible to write it down in scientific publications and therefore it is easier to access (Jensen et al. 2007).

Only a few recent studies in tourism examined interactions of the DUI-mode in concrete innovation cases (Henriksen and Halkier 2009, Strambach and Surmeier 2013, Lowe et al. 2012). Henriksen and Halkier (2009) analyse the process of bundling fragmented local marketing initiatives into a regional destination management organisation in North Jutland, Denmark. Specifically, the authors show how reluctant actors could be convinced to interact through the establishment of a network-based body constituting mutual dependencies. Strambach and Surmeier (2013) underpin how different actors, their specific knowledge, cultural and institutional backgrounds influence interactions of innovation processes. Their case is the development of a sustainable tourism standard and certification programme in South Africa. Lowe et al. (2012) provide insights into the evolution of self-organising networks and the role of human mobility in knowledge transfer. Their method was a longitudinal study of the development and diffusion of a boutique hotel chain in England which caused considerable change in the structures and routines of the destination system through spin-off enterprises.

However, in order to answer the questions raised above, further empirical insight is needed to achieve detailed knowledge about interactions of the DUI-mode. It is argued that a process-based perspective to study the emergence of interactions is particularly promising. It allows examining the development of tourism innovations from idea to implementation. How this has been done within this study is subject to the following sections.

5.3 Study Method

Data to shed light on doing, using and interacting while developing innovations has been acquired with the research approach of Innovation Biographies (Butzin et al. 2012). The key principle of Innovation Biographies is to reconstruct the process of innovation development from its first idea through to its implementation. This is done in case of concrete innovation processes and it can be examined how knowledge is generated and applied, what actors have contributed to innovation development, and what drivers and barriers determined development.

The basic idea of Innovation Biographies origins from biographical research applied in sociology (Wengraf 2001), where it relates to the intention to grasp the manifold impulses impacting on individual biographies (Fuchs-Heinritz 2005). The overall aim of biography studies is to explain broader-level societal structures based on insight derived from the micro-level, i.e. to uncover regularities from the study of particular small-scale developments (Wengraf 2001). The latter claim can also be assigned to Innovation Biographies. By transferring ideas of sociological biography research to innovations analysis, a considerable advantage is the possibility of disclosing micro-level peculiarities.

In order to do so, Innovation Biographies are guided by particular building blocks. First of all, innovation biographies are applied at a concrete innovation event as the actual locus of innovation creation. This is the level where actors exchange, combine and create new knowledge and, in fact, are challenged with the complexity of innovation. Thereby, Innovation Biographies

complement "meso-level" studies concentrating at destination systems, regions or countries.

Secondly, Innovation Biographies enable the analysis of inter-organisational interactions arising in accordance with the needs and requirements of the development process. Through network analysis, insight is obtained into the kind of actors that have taken part in developing the innovation, the knowledge they contributed, and the locations they came from.

Thirdly, Innovation Biographies incorporate a time-spatial dimension in which the biographical approach is combined with the conceptual thinking of time geography, and especially the instrument of time-space paths (Hägerstrand 1967). It enables studying the time-spatial unfolding of the development processes' dynamics.

These building blocks are transformed into a pragmatic research process following a multi-methodology approach (Mingers and Brocklseby 1997) conjoining several qualitative research methods. It basically combines tools of biography research, elements of time-geography, sampling and interviewing techniques as well as network analysis, to enable the reconstruction of the innovation's development process (Butzin 2012a).

The research process commences with a narrative interview (Jovchelovitch and Bauer 2000) in which a person with detailed knowledge about the development of a previously selected innovation narrates on the development process. The person is asked to reflect the situation in which the first idea arose, how it developed further including milestones and problems, what actors have been involved, the kind of knowledge applied, and how the innovation was implemented.

Subsequent interviews are then held with other actors of the innovation process. They are asked to reflect on their view upon the innovation process, and on their specific contribution. By carrying out several interviews with different actors based on snowball sampling to enlarge the sample (Biernacki and Waldorf 1981), a detailed picture of the innovation process and its interactions becomes visible. It sheds light on inter-organisational knowledge flows,

the emergence of the actor network, and the innovation's time-spatial unfolding.

The concluding step is to assemble the various pieces of interview information into a coherent biographical story of the innovation. If relevant, it can be complemented by further document analysis (press articles, homepages, etc.) to underpin interview data. The biographical story should start with the situation in which the first idea of the innovation arose, mention the kind of knowledge necessary for developing it, the actors from which the knowledge originated, and conclude with the factors by which the innovation was implemented. The term Innovation Biography, therefore, refers to both, the research procedure and to its outcome.

Results can be presented in a time-space path (Hägerstrand 1967) to visualise how the innovation process emerged over time and space and to illustrate interactions, knowledge applications, actors, the social network, and the different locations from which actors originate (cp. figure 4).

Applying Innovation Biographies brings along advantages as well as drawbacks. Advantages arise through the process perspective. Innovation Biographies provide detailed accounts of the dynamics of innovation development. They not only focus on knowledge generation and application, actors and social interactions, but also on the latter spatial scope and development over time. Furthermore, the study of innovation is not limited by predefined categories, be they administrative areas, industry classifications, or specific actor groups. Innovation biographies enable to analyse cross-relations and synergies that emerge between sectors and multiple territorial scales. Lastly, Innovation Biographies are constituted by a standardised set of research instruments that allows sound comparative research. The drawbacks relate to the fuzziness about the question when an innovation biography should start and when it should end?; furthermore, to the strong reliance on interview partners that tend to cooperate only in case of a successful innovation process rather than in case of failed innovation.

5.4 Knowledge Generation and Application from an Empirical Perspective

In the empirical section qualitative and quantitative data from nine Innovation Biographies is presented. However, as a first step, the section starts out with an in-depth qualitative illustration of one biography, namely the development of a thematic tourism route (football) in North Rhine Westphalia, Germany.

Data for this Innovation Biography was derived from seven in-depth interviews with actors involved in the innovation process. Two interviews were held with the director of the main innovating organisation, i.e. the Western German Football and Athletics Association (WFLV), and five interviews were carried out within other involved organisations, i.e. an ICT agency, a football club, a university, the regional tourism organisation, and a ministry of North Rhine Westphalia. To build the Innovation Biography, information from all interviews was assembled into a coherent story and complemented by recherché of press articles, homepages, and site visits. In addition, a time-space path was constructed as a complementary feature to visualise the development of the innovation process. The qualitative illustration provides case-specific answers to the questions raised in the beginning.

The section then captures a quantitative perspective by comparing data from six Northern European and three Turkish innovation processes against each other. All have been carried out according to the standardised research process of Innovation Biographies and documented in an in-depth textual format. Thereafter, data of the textual formats has been codified according to the following codes: the kind of knowledge that was exchanged, the type of actor who has been involved; and the geographical origin of the actor, to enable quantitative analysis. A detailed account of the codes is provided further down.

Research was undertaken in the context of EURODITE, a large-scale European Research project of the 6th Framework programme (contract no. 006187). Within the EURODITE project, the selection of innovation processes followed a broad understanding of innovation, where emphasis was put on the devel-

opment process rather than on a radically novel outcome. According to this logic, a decisive selection criterion of the cases was that a certain change should have been initiated through the innovation development at local or regional level. For example, the development of a thematic tourism route is hardly considered a radically new tourism innovation. Nevertheless it was a new product for the destination and thus required actors to create new knowledge, change routines and implement new features, as shown in the following.

5.4.1 The Innovation Process of a Football Route

The idea to develop a football route as a new tourism product in the State of North Rhine Westphalia, Germany, arose in light of the forthcoming FIFA World Cup ™ 2006 in Germany and originated from the director of the Western German Football and Athletics Association (WFLV). The principle was to bundle the stories of diverse places that have written the region's football history in a well-balanced mix using traditions, symbols, history and modern football. The route was to combine second-order traditional working-class football clubs as well as Champions League qualifying teams, information about past and present idols, old pubs in which football clubs were founded and modern stadiums seating more than 80,000 fans. To achieve this, many different actors, more or less representing the different elements, needed to collaborate, combine their knowledge, and further develop the idea. They were brought together by the director of WFLV who was a person of great centrality within the development process and can therefore be labelled as the innovation leader (Pechlaner et al. 2005).

First developments relating to the idea articulation in the year 2004 happened in the organisation WFLV without contribution from external actors.

> "I firstly developed the idea by my own and then discussed it with the president of WFLV. His support was prerequisite for searching further cooperation partners" (director of WFLV, first interview – *author's translation*).

Partner acquisition and network building to broaden the competence portfolio happened in summer 2005. A decisive criterion was finding knowledge complementary to the sports-related expertise of the WFLV that would further the route's development (i.e. specific knowledge about the history of the route's locations and marketing knowledge). Time setting could not have been better. With the forthcoming FIFA World Cup ™ 2006, there was a general enthusiasm about football and many actors were eager to connect to the event in whatever form. This 'window of opportunity' accelerated network building.

Three research institutions became actors within the network. Knowledge input related to historical information and an expertise about the route's value-added potential. Two further actors came from the education sector, one being a business school which had the function of developing a management concept, the other a social business specialised in integrating people into the labour market through event management. The North Rhine Westphalia tourism organisation was involved in order to providing knowledge relevant to networking and marketing, and fifteen municipalities set the physical environment for the route.

> "We contributed to the route's development insofar, as we have motivated the different regions to participate. We have been an important partner for the external communication and have done marketing for the football route" (Interview with North Rhine Westphalia tourism organisation – *author's translation*).

> "The main motivation to take part was that football is very important for our city and the region. Furthermore, the football route complemented and expanded our products" (Interview with City marketing Dortmund – *author's translation*).

Furthermore, a call for projects targeting at innovative tourism developments projects from a North Rhine Westphalia ministry stimulated the actors to develop and submit a proposal.

By establishing contact with actors external to the WFLV, the network was now able to include knowledge related to the locations' history, management, and marketing in addition to the sports-related knowledge held by the WFLV itself. The sectoral origin of the actors coming from research, education, tourism, and the public sector was as diverse as the knowledge contributions. However, to date the network's spatial spread remains at the destination level. The interactions and their characteristics are summarised in table 3.

Table 3: Actors and knowledge flows until summer 2005

Actors	*Content of interactions (type of knowledge)*	*Sectoral origin of actor*	*Geographical origin of actor*
Fifteen cities	location, history	public sector	regional
Goethe Institute	history	education & culture	regional
Cologne Business School	management	research, education	regional
NRW Tourismus e.V.	marketing	tourism	regional
Westphalian University	management (expertise)	research, education	regional
Willibald Gebhard Research Institute for Sports and Society	history	research	regional
Ministry	management (project proposal)	public sector	regional
Friends in Germany e.V.	marketing	education	regional

Source: own compilation, data based on interviews

Implementation of the route up to June 2006 (the month of the world championship) began straight after the constitution of the network. Parallel to implementing the physical infrastructure, marketing channels were set up through diverse media such as a travel guide, flyers, and a homepage. A sports-journalist became of central importance. He worked with the WFLV director to write the travel guide and coordinated the set-up of a public relations strategy (for example through contacting one of Europe's largest sports-related publishing houses which eventually published the travel guide). Marketing activities included presenting the travel guide at the Frankfurt Book Fair which is known as the largest of its kind in the world. As a result, the network of actors and interactions grew in particular to include marketing and publishing knowledge (table 4).

Table 4: Actors and knowledge flows until June 2006

Actors	*Content of interactions (type of knowledge)*	*Sectoral origin of actor*	*Geographical origin of actor*
Sports journalist	marketing (publishing), designing the route	media	regional
Marketing agency	marketing (design of homepage)	media/ICT	regional
Publishing house	marketing (publishing)	media	national
Frankfurt book fair and book shops	marketing	media	national
Some football clubs	marketing (presentation of the travel guide)	sports	regional

Source: own compilation, data based on interviews

Whereas the network was more diverse in terms of contents of knowledge, actors and sectoral origins in the previous phase, it now developed a thematic focus on marketing but with a broader geographical spread including the national level.

Synchronizing the route opening with the world championship was an important milestone. Thereafter (mainly June 2006 until 2009), developments were characterized by testing side-products supporting the route´s entertaining character. The offer is broad ranging from mobile media travel guides, bicycle tours, tours with former players, and vintage car rallies. Newly associated actors provided technical knowledge (e.g. in case of the mobile media travel guides) and knowledge for designing the car rallies and the bicycle tours.

Another milestone was the foundation of a formal football route association. The complete efforts and interactions were now bundled into a formalised structure. Among others, founding members included major regional football clubs. With the formalisation, marketing organisations of two other cities (Hamburg and Berlin) became interested in the concept and initiated collaboration with the WFLV. Again, the network expanded in terms of actors and their geographical origin, sectors and the diversity of knowledge inputs (table 5).

Table 5: Actors and knowledge flows until 2009

Actors	*Content of interactions (type of knowledge)*	*Sectoral origin of actor*	*Geographical origin of actor*
Football clubs	image creation	sports	regional
Regional Banks	no knowledge flow but a stimulant of subsequent knowledge flows	finance	regional
European Commission, State of NRW	no knowledge flow but a stimulant of subsequent knowledge flows	public sector	regional
ADAC (General German Automobile Association)	car-route and vintage car rally, designing the route	automotive	national
IT-company	technical, design	ICT	national
Tourism organisations of other cities (e.g. Hamburg and Berlin)	diffusing the idea	tourism	national

Source: own compilation, data based on interviews

5.4.2 Intermediary Conclusions

As mentioned above, a key element of Innovation Biographies is the illustration of a time-space path to visualise the evolution of the social network, the knowledge it contains, and its spatiality (cp. figure 4). The bold arrow indicates the time-line of the Innovation Biography (from 2004-09), with the WFLV being located in the City of Mülheim an der Ruhr (large circle) in North Rhine Westphalia. The lines represent the actors' locations, their date of initial participation within the innovation process and their sectoral origin.

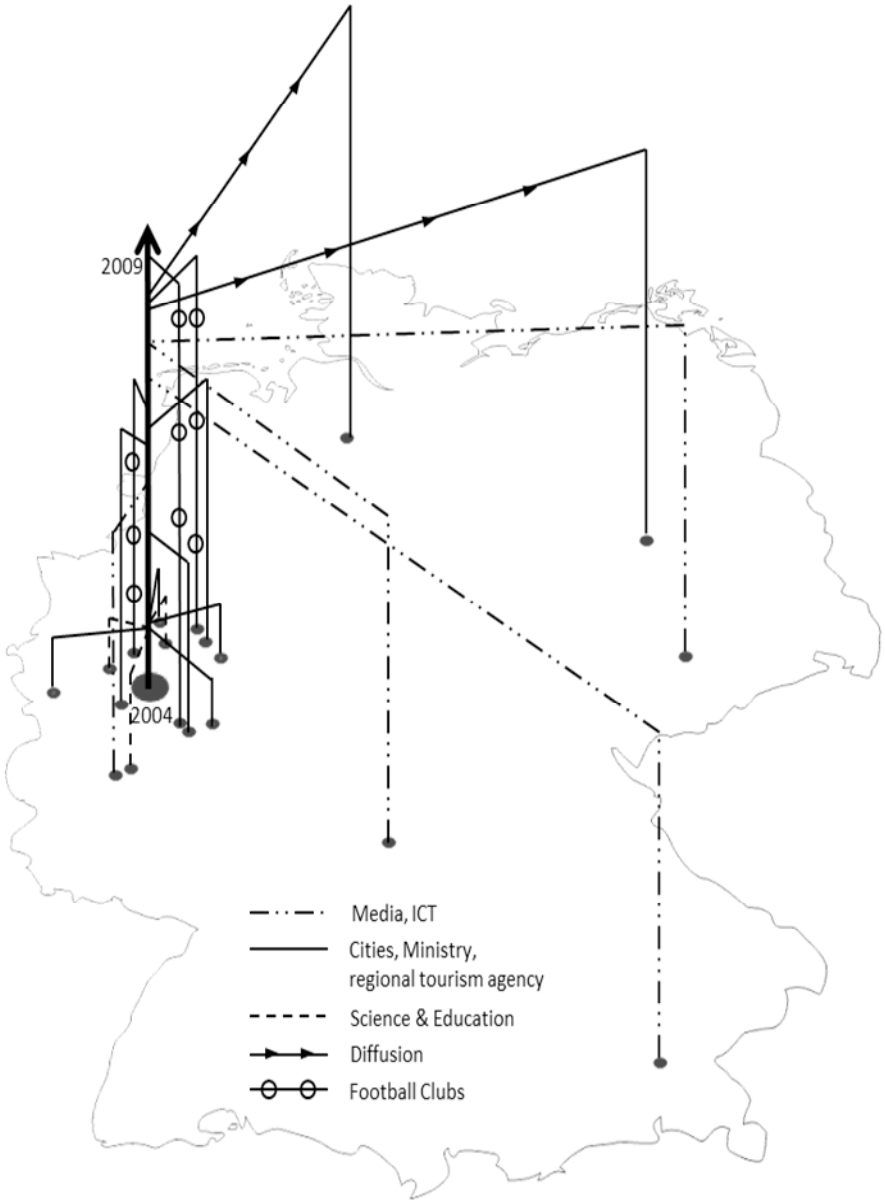
Several conclusions can be drawn from the reconstruction of the football route's innovation process. It illustrated that new developments are not necessarily based upon the generation of completely new knowledge. Instead, the selection and *creative fusion of formerly fragmented (regional) pools of existing knowledge* brought together due course constituted the driving force of the process. This implicates that knowledge generation and application within the innovation process was heavily characterized by *knowledge combinations* (Strambach and Klement 2012), i.e. the knowledge originated from

different sectoral contexts and was newly combined for the purpose of developing the tourism route.

Strongly related to knowledge combinations is the *diversity of actor types* coming from a variety of sectoral and institutional backgrounds such as research and education, tourism, the public and private sector, as well as media, marketing and ICT. The diversity is a consequence of the innovation process' ever new requirements. To form this network, the WFLV brought *previously known actors and unknown actors* together.

Furthermore, the interactions taking place at regional and national scales indicate *knowledge exchange between the destination and destination-external knowledge sources*. In geographical terms, the innovation development was broadened at a time when the content of knowledge flows became more specialised, i.e. when it required the development of targeted marketing measurements. One interpretation of the national stretch-out is that such specialised knowledge was not available at the level of the destination and that there are only a few actors in Germany able to provide it.

Figure 4: The Time-Space Path of the Football Route



Source: own illustration, data based on interviews.
For reasons of better visualization, not all of the 15 cities are represented.

5.4.3 Knowledge Generation and Application through a Quantitative Lens

As a complementary analysis to the in-depth case study of the football route, this part aims at analysing knowledge generation and application in nine innovation processes through a quantitative lens. Data has been codified from the respective nine in-depth biographical stories. In order to do so, the first interaction with a new actor that appeared in the innovation processes (154 new actors/interactions in total, 17 on average per innovation processes) has been codified according to the variables type of actor, kind of knowledge, and geographical origin of the actor. Variables have been defined as follows:

Types of actors involved within the innovations have been codified as *private* (e.g. marketing agencies, hotels, tour operators), *public* (local/ regional/ national authorities, universities), and *semi-public* actors (tourism organizations, associations).

In order to operationalize kinds of knowledge in innovation processes, phases of an innovation process from research and testing to marketing and implementation have been point of reference. Accordingly, knowledge is labelled as research-related, when it refers to scientific knowledge or market research. An example of research related knowledge is the provision of the historical information for the football route. *Development/design* (trying, testing, and furthering the idea) knowledge refers to knowledge that shapes and enhances the innovation idea and that accounts for the innovation's uniqueness. It is the key essence of innovation development. In the case of the football route, the design was mainly carried out by the WFLV. Examples are the selection of the different locations, the addition of the mobile media travel guides and the vintage car rally. *Marketing* knowledge refers to the production of marketing material (in various media formats) and the carrying out of promotional events. *Implementation* knowledge relates to finance, management and law – i.e. technical and organisational components that are necessary to implement the innovation.

The origin of each actor was defined as being either on a *regional, national* or *international* scale in relation to the location wherein the innovation was developed. It illustrates the geographical reach of the interactions and thereby

the locations of the diverse knowledge sources utilised in the innovation processes. The innovation processes from which data is drawn are introduced in table 6.

Table 6: Content of the studied Innovation Biographies

Name of Innovation Biography	*Content of innovation process*	*Country*
Top of Denmark – North Jutland	Establishing supra-local destination management organisation.	Denmark
All year tourism Mariagerfjord	Prolonging the destination's season.	Denmark
Museum Journey	Setting-up an innovative internet platform for regional museums.	Denmark
Route of Industrial Culture	Developing a tourism route (industrial culture).	Germany
Football Route, Germany	Developing a tourism route (football).	Germany
The film track	Developing a tourism route (film).	Sweden
New Hotel Concept	A completely new hotel set-up.	Turkey
Football Tourism	Establishment of football tourism as a new market segment.	Turkey
Beachpark Funpark, Turkey	Developing a 24 hrs leisure park on a former brown field.	Turkey

Source: own compilation

It is differentiated between the six Northern European and the Turkish cases, because of the different contexts: In the Northern European countries tourism is important at selected subnational levels, but does not belong to the countries' leading branches (e.g. in terms of turn-over or employability). The Turkish cases are innovations developed in a context in which tourism is a traditional major driver of economic development on country-wide basis.

Accordingly, there are some remarkable differences within the expressions of the variables of the two different groups of innovation processes, as shown in table 7. Considering *types of actors* in the Northern European innovations (table 6), three quarters (75.6%) of the interactions are from public and semi-public actors and only one quarter (24.4%) from private actors. The

picture is reversed in the Turkish cases, where private actors provide the clear majority of interactions (84%). Based upon the results it can be interpreted that the driving forces of the Northern European innovation processes have been public and semi-public actors, and private actors of the Turkish cases. Whereas the influence of the public sector in Northern Europe's tourism sector is well-known, understanding its concrete role in innovation projects and resulting consequences might thus be a future research issue.

With regard to *kinds of knowledge*, the proportion of design and marketing related knowledge is similar among the Northern European and Turkish innovations. Differences appear between knowledge related to research and implementation. Accordingly, 16% of interactions were dedicated to transfer research knowledge in the Turkish innovations, but only 5% in the Northern European ones. In turn, with one third (31%) interactions related to transfer implementation knowledge are much more prominent in the Northern European cases than in the Turkish case (12.9%). It allows the conclusion that competences regarding the implementation of innovations (e.g. finance, management, law) was generated, or was available within the Turkish innovating organisations, but it needed to be sourced from external actors in case of the Northern European innovations.

With respect to the *origins of actors*, in the Northern European cases, there is a clear dominance of the regional scale (73.2%) over the other two (national 19.5% and international 7.3%). Thus, the regional scale is an important source of knowledge and cooperation partners when innovating. The Turkish innovation processes are constituted by the interplay of regional (54.8%) and international interactions (35.5%) with the national scale being of minor influence (9.7%). According to these figures, the balancing act of local resources and international trends within innovation processes (Pechlaner et al. 2005) can only be found in the Turkish innovation cases, whereas the Northern European innovation actors seem to see benefits when cooperating on the regional scale. Furthermore, the difference mirrors the constitution of the respective markets which are more internationally oriented in case of Turkey and regionally-oriented in Northern Europe.

Table 7: Northern European and Turkish innovation processes compared

Types of Actors

	Northern European Innovations	*Turkish Innovations*
	absolute (%)	absolute (%)
Public	37 (30.1)	4 (12.9)
Semi-public	56 (45.5)	1 (3.2)
Private	30 (24.4)	26 (83.9)
n	123 (100)	31 (100)

Kinds of knowledge

	Northern European Innovations	*Turkish Innovations*
	absolute (%)	absolute (%)
Research	6 (4.9)	5 (16.1)
Design	43 (35)	12 (38.7)
Marketing	36 (29,3)	10 (32.3)
Implementation	38 (30.9)	4 (12.9)
n	123 (100)	31 (100)

Geographical origin of actors

	Northern European Innovations	*Turkish Innovations*
	absolute (%)	absolute (%)
regional	90 (73.2)	17 (54.8)
national	24 (19.5)	3 (9.7)
international	9 (7.3)	11 (35.5)
n	123 (100)	31 (100)

Source: own calculation

In the next step of analysis, it will be of interest to correlate the variables in-depth while continuing to compare the two groups of innovations with each other (figures 5-8). Accordingly, the kinds of knowledge are broadly spread across actor types in the Northern European innovations. With the exception of research-related knowledge not being provided by semi-public actors, all other possible knowledge contents were contributed by public, semi-public and private actors. Knowledge specialisation becomes visible in the case of the semi-public actors which mostly provided implementation related knowledge: 24 out of 38 (63%) of the implementation related knowledge

inputs came from semi-public actors. Due to the dominance of private actors and the minor presence of public and semi-public actors, the correlation of actors and knowledge inputs in the Turkish innovations basically shows the distribution of the different knowledge contents as a whole.

There are some obvious differences between the Northern European and Turkish innovations in the correlation of the actors' geographical origins with the kinds of knowledge – i.e. when asking what kind of knowledge originated from the regional, national or international scale. The differences specifically concern the origins of design related knowledge as knowledge through which the essential idea of the innovation process was brought forward. Designing the innovations in the Northern European cases was an activity mainly carried out with regional actors at the regional scale thus being based on local knowledge (cp. also the findings above). This 'regional' way of organizing the actor network and knowledge flows is also illustrated in the case of the football route and might be a consequence of the strong involvement of public and semi-public actors. By having a much more spatially open way of innovating, the majority of design related knowledge interactions came from the international scale in the Turkish cases. They are characterized through interactions reaching to Dubai, Russia and many countries in the European Union.

The different spatial patterns can be interpreted as two approaches to cope with the high rivalry in the immediate neighbourhood of tourism actors (for earlier considerations in this aspect cp. Butzin 2012b). In the Northern European innovation processes, innovators seem to "assimilate" by including regional actors that otherwise could potentially imitate the innovation. The Turkish innovation actors seem to "distinct" by including much essential design-related knowledge from international sources rather than from the regional scale. This constitutes a unique selling point allowing considerable innovation advancements over local competitors. It thus can be concluded that the context of tourism innovation, especially related to the strongly competitive environment, had significant implications for the shaping of interactions in the innovation processes.

Figure 5: Actors & kind of knowledge (Northern European innovations)

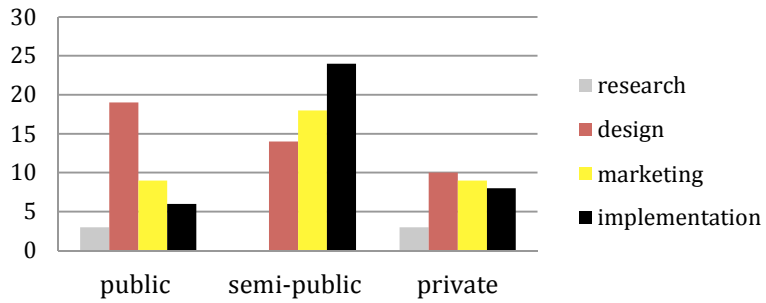


Figure 6: Actors & kind of knowledge (Turkish innovations)

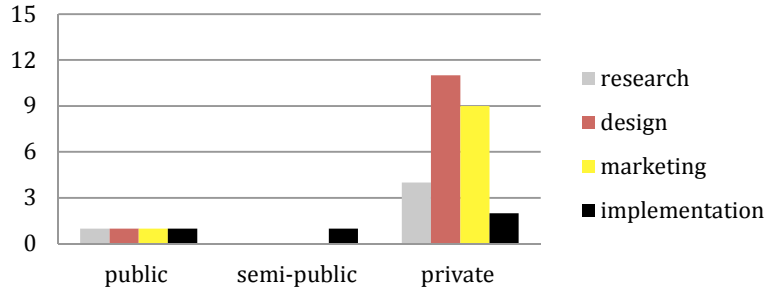


Figure 7: Geographical origin & kind of knowledge (Northern European innovations)

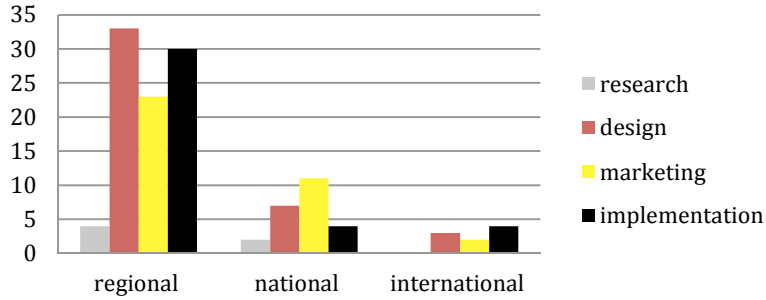
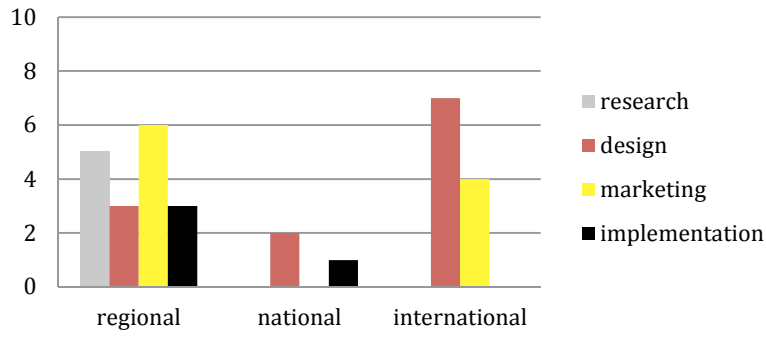


Figure 8: Geographical origin & kind of knowledge (Turkish innovations)



5.5 Summary and Conclusions

The aim of this study was to examine the nature of knowledge generation and application through three distinct research questions: "What kind of knowledge is generated and applied in the innovation process?"; "What actors take part?" and "Which locations do they come from?". Based on a literature review, it was elaborated that the development of tourism innovation is constituted by the doing-using-interacting (DUI) mode of innovation development (Jensen et al. 2007).

The qualitative analysis of the football route's Innovation Biography provided in-depth insight how knowledge was generated through the creative fusion of formerly fragmented pools of existing knowledge. Based upon this, it was suggested that the kind of knowledge generated and applied is mainly of combinatorial nature (Strambach and Klement 2012). This might be a contrast to high-tech oriented branches, for example biotechnology, of which innovativeness heavily relies on the exploration of scientific knowledge that is completely novel, rather than on combining existing knowledge.

The research questions where then studied through quantitative analysis. In order to do so, 154 interactions of nine innovation processes have been analysed and compared according to Northern European and Turkish innovation processes. There are some remarkable differences in knowledge generation and application between the two sets of innovation processes. Accordingly, it can be differentiated between an "assimilation approach" (Northern European cases) and a "distinction approach" (Turkish cases) to innovation development. In the first, knowledge of different regional actors is assimilated through intense regional cooperation. Thereby the risk of a quick imitation of the innovative idea is minimised, since potential competitors are included. Within the second approach innovation actors strive to distinct from regional competitors by integrating knowledge from international actors that cannot be easily copied by others into their innovation processes.

Due to the many actors that have contributed to developing the innovations (17 on average per innovation process), intensive communication seems to be a main driver of innovation development in tourism. Communication might thus be the DUI's counterpart to laboratory experiments of the STI-

mode of innovation development, at least from the perspective of tourism innovations. Furthermore, communication intensity needs to be seen in congruence with the high intangibility and service-orientation of tourism products. Such products cannot be developed based on material combinations, prototypes, or computer simulations, which might reduce the necessity of a similarly high degree of communication in other branches.

Furthermore, actors that contributed to the innovation processes belonged to different sectors and had different institutional backgrounds. The related diversity of knowledge inputs suggests knowledge combinations being a further significant driver of tourism innovations. Accordingly, the process of developing tourism innovation should be interpreted as a cross-sectoral, networked activity, i.e. an activity not only endogenously derived from within the sector, but rather by the novel re-combination of useful bits of many sectors. To substantiate this understanding, it might thus be helpful in future studies to examine tourism innovations in differentiated value chains rather than as purely sectoral phenomena. Findings might also be of relevance for the set-up of future policy programmes through which tourism innovations shall receive support. It seems promising to support cross-sectoral ideas and diverse actor constellations in project consortia rather than targeting on tourism actors in a narrow sectoral sense. In addition, it might be an option to enable the integration of new partners in later stages of funded projects to be able to respond to the challenges arising due course. With reference to destination management organisations, it might be fruitful to carry out Innovation Biographies of innovations developed in the destination and thereby analyse the research questions from a location specific perspective as a basis for the targeted development of innovation supporting infrastructures.

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CHAPTER 6

The Balance of Change and Continuity in the German Construction Sector's Development Path

6.1 Introduction[15]

With its high share of physical work and usage of machinery equipment, the construction sector does not belong to the classic knowledge-intensive high-tech industries. Nevertheless, there is a high frequency of knowledge creation and application. Every construction project is adjusted to local circumstances and therefore has a large share of newly developed non-standardized components. With regard to planning, particular effort is put into combining the specifics of the local area with technical requirements, design aspects and regulatory, as well as environmental, standards. In the physical construction phase, new knowledge is created to solve unforeseen problems arising during the building process (Senaratne and Sexton 2011). Such a situation brings together actors from different trades: engineers, architects or building owners and stimulates knowledge sharing and combinations which result in the development of new processes, communication structures, products or services.

However, a specific renewal paradox formulated two decades ago (Kadefors 1995; Ekstedt et al. 1992) is still existent in the construction sector: The project-based nature alongside a variety of actor constellations, theoretically, favours novelty, change and the freedom to experiment with new ideas. One might expect a high degree of flexibility as every project starts from scratch thereby requiring distinctive knowledge combinations and actions that continually reshape routinized behaviour and institutional settings. However, when new ideas and innovations are to be scaled-up, the project-based nature constitutes a major barrier since it hinders knowledge diffusion. The

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reasons are manifold but all originate from local circumstances of 'projectification'. Knowledge can be inappropriate for the next project, e.g. it does not match the requirements of the new locality, a particular actor constellation or machinery equipment as prerequisite for a specific application is not present, or knowledge has been forgotten (Grabher 2004) due to non-existent (Styhre 2008) or not consulted (Larsen 2011) company-internal project evaluation procedures.

This problem is addressed by current innovation dynamics in construction aimed at minimizing the large degree of knowledge waste and efficiency loss. Though varying in quality and scope, the innovation dynamics have the important commonality of attempting to overcome manifested structures and routines that have been established as a result of the project-based localized logic. They bring about new ideas, products or organizational settings as they are able to cross project boundaries. Main catalysts are the improvement of technical capabilities by developing highly sophisticated tools and machinery flexible enough to be used in different places, prefabrication of buildings and the establishment of an organizational service-oriented set-up beginning before and reaching beyond the physical project phase in order to facilitate communication among actors.

A second important characteristic of these innovations is their foundation on knowledge combinations with sources from different sectoral and organizational domains (Strambach 2008; Crevoisier and Jeannerat 2009). Concerning the improvement of technical capabilities, the major knowledge flows come from machine construction, i.e. a peripheral part of the sector's value chain where working routines differ considerably and have more similarity with engineering than with construction. The idea of prefabricated construction heavily relies on the structures of other producing industries, especially the automotive industry, as houses are built within a permanent production facility. As regards new organizational (service) routines, influences are coming from new management approaches and include a general orientation towards a service-based economy and the ICT sector.

The current situation in construction provides fruitful ground for studying the major research topic of this special issue, namely the relation between

path dependency, path plasticity, and knowledge combinations. While some of the other contributions have an explicit spatial orientation, this paper studies path plasticity primarily from a sectoral perspective, though the matter of locality will be emphasized. In line with Strambach (2010), path plasticity is understood as the range of possibilities through which change is shaped within an industry's dominant development path without resulting in its total transformation. Thereby, the notion of path plasticity takes the critique of a too strict and polarized view of path development being either considered as incremental or radical as a starting point. Incremental change is seen as a mechanism supporting continuous path development and institutional stability through positive feedback mechanisms and increasing returns (Pierson 2000). Institutional adaptation happens without troublesome 'periods of mismatch' (Dosi 1988) between the market and its corresponding institutional framework. On the other hand, radical or disruptive change is seen as leading to the total transformation of an innovation system's development path, since the mismatch between market trends and institutional frameworks is irreconcilable. This polarity neglects the many facets of change happening between structural/institutional stability and radical system disruptions (Streeck and Thelen 2005; Dolata 2008; Strambach 2010) that in this special issue will be studied under the aspect of path plasticity.

In the paper, path plasticity is explored through the balance of change and continuity within innovation dynamics in construction. The balance of change and continuity is considered as the specific sectoral scope for path plasticity providing the "corridor" in which change happens without causing radical change. It needs to be negotiated among actors and institutional frameworks. In the case of construction, this will especially concern the labour-market, the inter-firm division of work and related governance structures. Depending on the innovation, the degree of change required for its implementation differs and hence related path plasticity and the impact on the direction of sectoral change as a whole.

The paper begins with discussing the context of knowledge production in the construction sector both with regard to internationally effective and specific German attributes. As shown below, it is fundamentally configured by the project-based nature and resulting spatial fragmentation. The paper then

analyses the current innovation dynamics aimed at changing manifested project-based working routines and overcoming localized structures. They are discussed from an analytical point of view and exemplified by a number of concrete innovation cases that have been intensively studied within the frame of national research projects on the sector's innovation dynamics. The cases are assessed according to their degree of change and potential impact on the direction of sectoral development. The paper concludes with a discussion of the balance of change and continuity in the development path of construction and its implications for understanding path plasticity and knowledge combinations in economic change.

6.2 The Context of Knowledge Production in the Construction Sector

The construction industry is a project-based industry par excellence (Grabher 2002; Dubois and Gadde 2002) and the generation of practical knowledge for planning and executing projects is both positively and negatively influenced by the project nature through which each project can develop unique characteristics (Styhre 2008). Uniqueness originates in the place-specifics of the site, different building owners, the environment or the legal frame and requires tailor-made solutions since one-size-fits-all attempts are likely to be inappropriate. Often, solutions are developed as a reaction to problems arising during the construction process (Senaratne and Sexton 2011) that need to be solved quickly and efficiently with the competences at hand. They have a considerable tacit dimension and are derived from the experiences of different trades.

The German construction sector – main characteristics

In 2010, around 2.4 million people with social insurance were employed in the German construction industry (11% of all employees with social insurance in Germany). With the exception of the two companies Bilfinger Berger and Hochtief which belong to the ten largest construction companies in the world, the German construction industry consists of small and medium sized enterprises (SMEs). On average, German construction companies have 10 employees (which is above the European average of approx. 6 employees).

The small-scale company structure goes hand in hand with a spatially dispersed distribution of the value-added chain. This results in a low level of competitiveness at international, and even interregional, level. Even though European efforts concerning common standard setting are continuously implemented, there is still a strongly national-oriented development path. Technical and labour-market regulation, trades being limited to specific functions and sectoral governance structures characterized through inter-firm division of labour, concretize the specifics of the path (Nordhause-Janz et al. 2011).

As a general characteristic of project-based industries, there is a high risk to 'reinventing the wheel' in many projects, or put differently, there is the possibility of high knowledge waste (Sydow et al. 2004) since knowledge transfer across projects appears to be a challenging task. Rose and Manley (2012) consider innovation adoption in construction as being particularly hampered by the sector's complex innovation system that has an 'innovation gap' (Taylor and Levitt 2005) between the project and the cross-project meso-level thus hindering innovations and knowledge which are to be scaled-up. Therefore, in an approach to minimize knowledge loss, Engwall (2003) makes a plea for construction projects not to be viewed as isolated islands but for conceptual and practical discussion on transfer channels, communication and storage mechanisms to anchor the single project in its wider context (cp. also Carrillo et al. 2011). The innovation strategies analysed below should be viewed in this light.

Further distinctive characteristics of the sector provoked by the project-based nature are a high degree of complexity, local boundedness, loose coupling, and a strong institutionalization (Butzin and Rehfeld 2009). These characteristics constitute the context of knowledge production in construction and are essential for understanding the sector's structural deficits which constitute the 'innovation gap'.

6.2.1 Complexity

Construction projects are among the most complex production activities in the economy. They require intensive knowledge exchange and well-established communication channels among the actors involved. Gidado (1996) notions two basic features of the complexity namely uncertainty and interdependency. Uncertainty arises due to the one-off nature of construction projects (see also Dubois and Gadde 2002: 622): the local environment is unfamiliar to management, i.e. the site may, at some stage, disclose unforeseen challenges, new and unknown actors may appear, material delivery and workflow might not match sufficiently, building owners might change their minds about design features, and importantly, weather is unpredictable and can cause major process delays. The high level of uncertainty leads, according to Jennings (2012), to a systematic underestimation of costs in large-scale budgeting processes and even more so in mega projects. His very recent example is the budgeting of the London 2012 Olympic Games where costs exceptionally overran. Interdependency relates to sequencing various operations to form a workflow. The major challenge lies in coordinating activities and maintaining an appropriate time-space synchronization of the different trades to ensure a maximum level of efficiency (put simply, a painter cannot start painting a wall before is has been finished). Construction projects commence with comprehensive planning which combines knowledge related to engineering, law and regulations, architecture, planning, design, and project management. With the physical beginning, manifold processes happen simultaneously constituting an interdependent network with complex interfaces (Gann and Salter 2000). Knowledge and competences of different trades, high or low tech, manufactured or standardized, are combined and adapted to the building's uniqueness and local specifics.

6.2.2 Locally Bounded

In contrast to industrial value chains where products are manufactured at permanent locations, the construction sector usually produces within 'moving factories' in which products are visibly or invisibly adapted to local specifics. Even with increasing standardization and industrialization, the physi-

cal environment of every project requires new knowledge combinations of routinized and tailored solutions (Dubois and Gadde 2002). Local dependence limits the potential for economies of scale leading to a comparatively low level of national or international expansion. As a consequence, most German construction companies are medium sized and operate on a regional basis (Bosch and Zühlke-Robinet 1999, Nordhause-Janz et al. 2011). Another disadvantage of local boundedness is a spatially dispersed sectoral structure, since a process of industrial and spatial concentration, as for example in automotive or engineering industries, has not taken place. This has direct implications for knowledge creation, flows and diffusion. Similar stocks of knowledge are rather equally distributed across space. Every construction project can be considered as a knowledge creating entity constituted by regionally-based actors. However, they still need to start from scratch and the call for many repetitive components remains (cp. the renewal paradox). Against this background, the development of highly specialized knowledge seems to be economically inappropriate, since it cannot be applied in daily projects operations. This has resulted in a certain dualism of roles between the core parts of the construction sector where knowledge generation is practice-based, highly tacit and takes place incrementally by developing non-technological process and organizational innovations. In turn, high-technology specialization is found in the more peripheral parts of the value chain, especially in areas such as machinery equipment and new materials research.

6.2.3 Loose Coupling

Loose coupling in contrast to stable relations of actors is a direct implication of the project-based structure. Its advantage is its flexibility in arranging a constellation of trades and competences tailored to local conditions, rather than being bound to certain actors through formal contractual or informal dependencies (Dubois and Gadde 2002). Larsen (2011) considers loosely coupled actors and strong complementarity of knowledge bases a disadvantage in terms of developing working routines throughout the lifetime of a construction project. The different trade backgrounds alongside an exceptionally narrow time frame are a barrier for actors in overcoming their cogni-

tive distance and constituting a trustful and synergetic 'community of practice'. As an alternative when describing the characteristics of project-based industries, Sydow et al. (2004) and Lindkvist (2005) suggest the notion 'collectivity of practice'. 'Collectivities of practice' build to a lesser extent on a tightly knit group and the solid ground of a common knowledge base. They take advantage of loose coupling by linking diverse knowledge bases thereby enabling the combination of different knowledge domains. Such collectives depend on well-connected and informed individuals acting as facilitators and mediators in the process of knowledge integration. Of the broader consequences of the sector's loosely coupled structures is a segmented value chain with each part having separated regulations, logics and routines being even more intensified by the largely disconnected tasks of planning, design and physical construction (Manley and Mcfallan 2006; Butzin and Rehfeld 2009). Recently the latter aspect is increasingly being seen as needing to be approached from an integrated perspective combining planners, architects and practitioners in order to optimize efficiency.

6.2.4 Strong Institutionalization

Formal and informal institutionalization in construction is strong (Kadefors 1995) and its main function is to mediate stability. To a great extent, this is attributed to the complexity and uncertainty of construction projects, the long durability of buildings and the comparatively short construction phase, different trades working together and the large amounts of money spent on construction projects. In this high risk environment, institutions understood as formal and informal routines, rules, norms and regulations (cp. Edquist and Johnson 1997) are first and foremost considered as providing stability and only subsequently the soft features of giving orientation, guidelines and reliability.

Kadefors (1995: 401) distinguishes different institutional settings as rule-guiding in construction: *Legislative* regulations affect planning (zoning maps), buildings and building practices in terms of formal liabilities for the work done. *Standardization* is highly advanced in many aspects reaching from specified material properties to standardized contracts and from the

design of work processes to protective clothing. In the *tendering system* the building owner defines tasks to be undertaken and the related standards to be applied during a project and firms then bid on the job. Decisions are mostly taken on a least-cost basis and there is almost no room for firms to respond by offering work with a more radical innovation or procedure. Though less explicit, different *roles* in construction projects seem to be pre-defined and bring with them strong cultural norms and value-orientations (see also Pemsel and Widén 2011). *Learning and routine* arise through the uniformity of roles and play a large part in contributing to the value chain's segmentation.

In the following text we will analyse the innovation strategies of construction firms that tackle efficiency and competence losses related to the project-based structure. The innovation strategies especially concern the challenge of developing technical equipment and organizational routines flexible enough to be applied across different construction projects in order to overcome the locality-problem and the innovation gap caused by the distinctive sectoral characteristics as described above. The major analytical focus is to assess the degree of change required for their implementation – i.e. the question in how far they change labour-market structures, the inter-firm division of work or related governance structures.

6.3 Changing Project-Based Structures: Strategies, Knowledge Combinations and Innovations

As pointed out, construction is a very complex, locally bound process. Complexity calls for intense cooperation and communication – costs resulting from insufficient communication and misunderstandings between stakeholders are significantly high. The matter of locality is a major causation; there is widespread belief that the uniqueness and related problems of each construction project hinder standardized solutions.

Against this background, the three innovation strategies examined below can be considered as attempts to change the path-dependent production logic by overcoming attributes related to the project-based nature. The first focuses

on minimizing the specific problems resulting from local circumstances by enhancing *technical capabilities***.** The obvious way is to develop durable tools or machinery equipment that can be used in different places. The second is an orientation towards the industrialization models of other industries such as the automotive industry and mainly concerns the *prefabrication* of buildings within permanent production halls. The third aims at *expanding competences* thereby overcoming communication problems resulting from complexity, the loosely coupled interrelations and the unique character of building projects. New organizational and service models, as well as intensified applications of ICT based management systems, are the prevailing approaches. The three strategies will be discussed and underpinned by concrete innovation developments reflecting current activities. The innovation developments are then analysed according to their degree of change and the resulting impact on the direction of sectoral change as a whole.

Results are based upon research carried out in the light of two research projects[16] on innovation processes and strategies in construction which were funded by the Federal Ministry for Construction (Butzin and Rehfeld 2009; Nordhause-Janz et al. 2011). The field work to study the innovation processes was mainly undertaken using a qualitative research methodology called innovation biographies (cp. Butzin et al. 2012). The methodology is designed to obtain detailed insights of knowledge flows and dynamics of innovations. It applies a mixed-method approach which incorporates varying interview techniques and qualitative egocentric network analysis. The methodology enables reconstruction of the development process of an innovation from the initial idea through to its implementation as a service, product or organizational innovation.

6.3.1 Innovation Strategy I: Enhancing Technical Capabilities

Each construction project is unique and requires tailored technical solutions. Especially in larger construction projects, technical equipment and tools are

[16] Called "Innovation Biographies in the German Construction Sector" (Contract number Z.6-10.08.18.7-07.01) and "Innovation Strategies in Construction. An International Comparison" (Contract number SF-10.08.17.7-09.30).

developed to be applied in only one project. Alternatively, modularized, stepwise, technical procedures can be adapted and modified according to local specifics. However, both attempts have components of inefficiency; the new development of technical equipment (an example could be a temporary bridge in road construction) for each construction project is repetitive and time-consuming. The alternative suggestion could be subject to improvements by finding ways to combine two working steps. An example would be the new drilling process outlined below that combines the two steps of drilling and tunneling.

From a knowledge combination perspective, the strategy of enhancing technical capabilities in order to set them apart from the project-logic is of considerable interest, for several reasons. *Firstly*, the main actors setting out impulses come from the value chain's synthetic knowledge-based (Asheim and Coenen 2005) peripheral parts of machine building, material development or tool making. These are parts where sectoral borders intersect with engineering and where the knowledge generation processes and working routines are thus influenced by cross-sectoral knowledge combinations. This results, *secondly*, in routines being disentangled from the project structure of the construction sector's core parts. Actors are based in permanent locations and carry out continuous research and development activities that build upon each other. Therefore, it seems only logical that technical innovations developed in these parts of the value chain are designed for multiple usages in different places since developers are not confronted with the restrictions of projects on a daily basis. As a consequence, *thirdly*, the implementation of technical innovation in construction projects is an encounter of the two production logics "temporal project" vs. "continuous development" and their different knowledge domains "practice-based manufacturing/tacit" vs. "scientific/engineering". In what follows, two characteristic technical innovations are discussed to examine their potential for change in future path development.

A novel Drilling Process

The drilling process unites the two working steps of horizontal drilling and micro tunnelling and was developed by a world-leading firm for tunnelling technologies. An example of its application is the installation of a sewage pipe crossing under a river where the driller simultaneously installs the pipe while drilling the hole. The significant time saving achieved by simultaneous tunnel drilling and pipe insertion is a considerable efficiency saving innovation. Most challenging was the construction of the drilling machine in a way that allowed its application in all possible locations (e.g. different soil properties, horizontal and vertical curves, etc.). The pilot project was carried out in a southern German municipality where a new sewage system was installed across the River Rhine. Prerequisite to its implementation were changes in the municipality's tendering system.

Degree of change and potential impact on the direction of path development: The novel drilling process has won several awards due to its highly sophisticated technical applications and is among the firm's flagship products. Nevertheless, though clearly overcoming one-off applications, its potential for changing path development is limited since the innovation contributes to the further specialization of the company, does not diffuse and does not impact on working routines on a broader level. It follows a given path instead of initiating broader-level change.

A Re-usable Temporary Bridge

Temporary bridges are required in railway services if construction work needs to be done to a permanent rail bridge. The usual routine would be to statically calculate and design the temporary bridge and then build it for the sole purpose of an *ersatz-building* to be deconstructed as soon as the construction work is finished. Though this is an extraordinary cost-intensive procedure, it is repeated in every new project in order to meet local conditions (e.g. through varying lengths of bridges) and regulative aspects: Each time it is required to have type testing and to document the quality of the deployed steel. This is undertaken by an officially approved testing authority.

The quality management team of a leading bridge building firm suggested developing a new bridge that could be re-used in different projects thereby saving time and money. Similar to the drilling process, the major challenge was to include all possible project conditions, e.g. calculating from low to extreme weights of trains and considering different topographies (this is an illustrative example of how locality can limit the scope innovation or respectively call for extra creativity).

Another challenge was that official regulations had not foreseen the need for permanent permissions for the temporary installation of *ersatz-buildings.* Instead it was necessary to obtain permission for each new project. This included an intensive testing of whether the bridge was adequately constructed according to local conditions. In cooperation with the Federal Railway Authority a solution was found that included some re-labelling to finally certify permission as for a permanent installation.

Degree of change and potential impact on the direction of path development: Similar to the drilling process, the re-usable temporary bridge is more important in terms of company development than of path development. New technical knowledge was created in order to configure the technical requirements and has basically contributed to path continuation rather than to notable change, at least from a technical perspective. What distinguishes the bridge from the drilling procedure is its relatedness with the respective formal institutional setting and the consequence of changing parts of the existing regulatory framework that formerly followed a one-off logic.

6.3.2 Innovation Strategy II: Prefabrication

The more ambitious way to overcome locality is industrialization. Prefabrication of single components is the starting point; industrial production of complex sub-systems (walls with all infrastructures, such as heating systems) is the sophisticated further development. Both are produced at a fixed location in permanent rather than in “moving factories”. Numbers are growing in the case of car parks and office buildings, whereas it remains a niche segment in the area of school buildings and housing. The principle is to take advantage of

integrating as many working steps as possible under one roof by e.g. having full control over the workflow in terms of time-settings, material delivery, the building-up of routines through standardized production procedures and the integration of trades (now being all employees of the same company). Major influences come from sectors with industrialized production structures, especially the automotive industry, where permanent production facilities are an established component of the sectoral structure. There are two areas of knowledge combinations. Firstly, automotive production structures and knowledge concerning industrialization is combined with the requirements of the construction sector. Secondly, different trades are employed by one company including better opportunities of knowledge exchange. However, the market of prefabricated components and buildings is a complex one. In housing especially, implementation is confronted with the problem of consumer reservations against the uniform design of houses. A recent example of market failure was IKEA's prefabricated 'Boklok' house which only managed a few sales on the German market. The project attracted little interest and consequently it was cancelled in Germany (Bien-Zenker GmbH 2011).

The Case of School Buildings

The developing company was already considerably successful in the industrial production of commercial buildings and multi-story car parks with low-individuality building design. Schools seemed to be another type of building equally fitting into this logic and development began with a first construction project. During preparation, the building owners had been hesitant to assign the company, because of established scepticism towards prefabricated houses. Other problems concerned the prefabrication of higher stability and safety components thereby partly counteracting the advantages of the systemic construction system. These problems required external expert certification. Furthermore, the on-site assembling of components was done by an external company inexperienced in assembling prefabricated components. Therefore, considerable efforts needed to be put into training the external company's employees since the so-called 'systemic buildings' have higher workflow and construction requirements resulting in changing working routines.

Degree of change and potential impact on the direction of path development: We consider industrialized construction of buildings such as schools as highly influential in terms of overcoming the localized project-structure. It combines different actors' (trades) embedded knowledge in one place that not only provides the opportunity to develop from a collectivity of practice into a community of practice but also installs continuation for the improvement of routines and workflow procedures. However, how far a completely prefabricated house becomes a successful product or whether prefabrication reaches a certain limit and is only of relevance for commercial buildings and building components, remains an open issue.

6.3.3 Innovation Strategy III: Expansion of Competences | Overcoming Communication Problems

The third innovation strategy aims at expanding competences in order to overcome communication problems by intensifying service orientation and a stronger use of ICT based management systems.

Service orientation brings a shift from competition based on cost efficiency towards one based on the added-value of a product. It represents a transition from old modes of construction work towards new ones by focusing on services rather than on products (Oliva and Kallenberg 2003; Gebauer et al. 2008). Instead of targeting mere product delivery, construction firms increasingly put efforts into bundling design, construction and maintenance/facility management (Leiringer and Bröchner 2010). They concentrate on the entire life-cycle of a product with the broader aim of prolonging the firm's specific value-added chain by particular service components (Holm 2000). Building upon the firm-knowledge related to technical and engineering functions, it also implies an expansion of competences related to performance, quality management and customer relations (Leiringer and Bröchner 2010). The latter two are of particular importance, as in a service-based approach, the firm and the clients usually collaborate on a long-term basis which reaches far beyond the period of the actual construction process.

Indeed, such a change in the a sector's competition and working routines cannot happen without the generation and application of new knowledge domains through which service orientation is implemented and carried out. Dominant engineering and practice-based routines defined through materials, machinery and technical features are complemented by customer relation management, service design, financial engineering or marketing components and go hand in hand with the creation of completely new job descriptions. Furthermore, service orientation also affects the institutional arrangement. Not only is there an existing need for new contractual standards and finance models or for a new interpretation of roles from product deliverer to service provider, it also has major implications for working routines and the project structure of the sector as a whole. Though service-led buildings possess one-off characteristics and still can be considered as project-based, the life-cycle perspective prolongs the time-frame and thereby provides ground for the accumulation of knowledge including better opportunities for learning, feedback and process improvement.

A Service Oriented Business Model

In parallel to the above mentioned industrialized construction of schools, the developing firm has undergone a significant change towards a new business model with an integrative perspective on its activities. Concretely, this implied developing services and functions enabling the design, construction and maintenance of buildings instead of only fulfilling the core part of physical construction. The competence portfolio of the company was considerably enlarged, uniting all necessary competences for leading building projects from the beginning and throughout the entire lifecycle. Importantly, this results in efficiency gains since knowledge obtained during construction can be used for maintenance, or vice versa, knowledge of maintenance requirements can be included in the construction phase.

Degree of change and potential impact on the direction of path development: Impacts in terms of path change are medium to high; it changes actor constellations whereby construction firms now take over design and facility man-

agement. There are changes in power relations between clients and contractors evolving from their long-term, mutual relationship.

Building Teams

The organizational form of building teams originates from The Netherlands ('bouwteam') where it is a successful alternative to the general contractor model in which there are strictly separated roles between planning, construction and the building owner. It is designed for housing projects. Building teams have a flat hierarchy and integrate all relevant professions as well as the building owner already from the start. It begins with the common planning of workflow and intensive knowledge exchange of experiences across trades. Architects have a special role in building teams as they need to be a communication interface and coordinate the workflow. Working successfully in a building team requires a new understanding of traditional roles. Trade firms need to perform planning instead of mere construction; architects need to accept trade firms as equal partners.

Degree of change and potential impact on the direction of path development: Although construction projects with building teams have been carried out for almost twenty years, particularly in southern Germany, concept diffusion has happened very slowly. Despite comprehensive information, for example a manual of how to work in building teams published by the Chamber of Architects in Baden-Württemberg (Architektenkammer Baden Württemberg 2009), there are only selective building team projects. During the building process a lot of combinatorial knowledge exchange takes place in building teams. But as long as the concept is not adopted by others, its potential for sectoral change remains on a medium level.

Another component of the strategy to expand competences thereby overcoming the communication problems is intensive usage of ICT based management systems to simplify information flow. However, as yet, highly sophisticated IT systems seem not to be as promising as had been expected. One reason might be that IT systems and building projects are equally complex, as the following two cases show.

The limits of ICT: Renovation of a historic building and Building Information Modelling at the Elbphilharmonie

The renovation of a historic building illustrates the change of routines in project organization due to enormous time pressure. Deadline for renovation was the beginning of the European Capital of Culture 2010 in the Ruhr Area, Germany. Construction could not be started well in advance since the final approval for EU co-finance was outstanding. Many different working steps were conducted in parallel. Although the design phase was not finished, work independent of design and other planning was started and tenders for the interior were already published. Due to the situation, the contractor decided to downscale the use of electronically-based project management systems to a minimum as training all the users would have been enormously time-consuming. Normally, in large projects like this formalized communication channels and detailed information documentation are essential components for a smooth project flow. In this case, regular verbal meetings took place within a circle of those with top-responsibility in order to balance out the lack of electronically available information. Paper documentation too, was minimized to save time although this ran the risk of considerable knowledge loss should central people have changed their jobs or moved on.

Another case is the application of a 3D building information model in the (ongoing) construction process of the new concert hall Elbphilharmonie in the City of Hamburg. 3D building information models are developed in order to visualize a building to be constructed. They facilitate the planning phase in terms of simplifying decision-making and calculating expected costs. Every new development, e.g. a change in the floor plan, is fed into the modelling system which than calculates the resulting consequences such as new volumes of steel for the other trades. Moreover, it is also the basis for decisions taken during the life-cycle of a building up until its demolition. Right from the beginning, the planning and construction process of the Elbphilharmonie was based upon a building information model and the actual costs should have been known (theoretically). Nevertheless, the project was stopped half-way since costs for constructing the roof exploded during the processes. There is

currently a serious dispute between the City of Hamburg and the contractor Hochtief about who should pay.

Degree of change and potential impact on the direction of path development: It is questionable whether new competences in applying sophisticated IT-solutions facilitate the overcoming of communication barriers in construction. IT-solutions seem to be unable to compensate the tension between the need to explicate knowledge in order to provide information for the IT-system and the tacit dimension of experience-based knowledge crucial in the everyday-routines on construction sites. Though being hyped as a promising approach the improvement of communication does not depend on ICT. One hypothesis is that strengthening communication is more a social than a technical problem.

6.4 Discussion & Conclusion

The innovation trends which influence localized product-based production structures as discussed in this paper, underpin the potential of combining knowledge from different sectors and from along the value chain. However, since not every approach is equally effective in generating impact at the broader level, it is also important to discuss why some of the presented innovations seem to be less successful than others. This is especially important against the background of finding a balanced mixture of sectoral change and continuity describing the scope for path plasticity – i.e. the corridor in which change happens without causing radical transformation.

When looking closer at the innovation trends and cases, there are some observable patterns. Though clearly overcoming the construction sector's locality problem through process automation, the improvement of technical capabilities seems well-matched to the given sectoral path and optimizes it within a known development route. There is only a minor degree of "negotiating" with other actors or the formal institutional framework. Solutions to deal with barriers (long-term certification, finding a pilot project) that arise and which are part of any innovation process, are found within a reasonable time frame and without major changes of the technical components.

The picture is completely different in the case of prefabricated buildings. By adopting the industrialization logic of other producing industries, prefabrication highly affects the sector's working routines significantly through combining and integrating the knowledge of different trades, changing the established division of labour, allowing continuous long-term development processes and through the physical re-location of a construction project into permanent production halls. The implementation of prefabricated buildings results in a high degree of path plasticity, though being only applicable in certain segments of the sector (e.g. car parks, private housing, schools and office buildings).

The same is true for emerging service orientation. Contrary to prefabrication which changes existing structures, service orientation is connected to setting-up a completely new domain within the construction sector and is accompanied by the co-evolution of necessary structures through which it is implemented (e.g. public-private partnership models, new job descriptions, a growing importance of facility management, etc.). This new sub-sectoral domain is still an area of experimentation resulting in various models being tested out (building teams, life-cycle orientation, PPPs). With respect to ICT tools, it is noticeable that they partially face high bottlenecks during implementation and seem to have limited potential in provoking change in the sector's development path due to some resistance against them. The current requirements to gainfully use Building Information Models or ICT-based project management tools seem to be too high and to date they have not helped to reduce complexity and communication problems. An underestimated explanation is that in order to fully plan a construction process with ICT, large amounts of tacit knowledge need to explicated and fed into the software. This kind of bridging or combinatorial capability between tacit construction knowledge embedded within the trades and formalized, electronically-based planning and communication tools needs further improvement. The following table (table 8) summarizes the key determinants of each innovation process in terms of knowledge sharing and combinations, resulting bottlenecks and the potential impact on sectoral change.

Furthermore, some considerations should be made concerning the role of the institutional framework. Overcoming project structures seems to concern

formal and informal institutions equally. With respect to the regulative framework constituting the context of working routines, flexibility to implement innovations is established through finding creative solutions within existing regulations rather than through the establishment of new ones. Examples are the renaming of the temporary bridge that allowed permanent type approval, differently interpreted tendering procedures, or expert certifications balancing out a lack of institutional standardization. In other words, there seems to be scope for the flexible interpretation (Strambach 2010) of the formalized institutional framework.

However, the potential for significant sectoral change rests with the development of new working and organizational routines connected to the more informally constituted institutions (Edquist and Jonson 1997). Taken together, they are much more promising in terms of uncoupling from the project-based structures and the related problem of local boundedness. They not only imply the cooperative set-up of teams constituted by clients, project managers and trades but also result in new building teams, prefabrication of buildings, and a life-cycle orientation. Furthermore, they allow the tapping in to various knowledge sources of the entire construction's value chain and of other sectors.

Table 8: Overview of innovations and impact on sectoral change

	Type of innovation	*Mode of knowledge sharing & knowledge combinations*	*Bottlenecks*	*Impact on sectoral change	path plasticity*	*Path-changing idea behind*
Drilling process	Process innovation (technical).	Starts out analytically based with need for contextualization during pilot.	Medium (difficulties in finding a pilot project).	Limited, optimization of the given path, mostly change of internal routines.	Process automation.
Temporary bridge	Process innovation (technical).	De- and re-contextualization (from a one-off tool to reusable).	Medium (certification).	Limited, optimization of the given path, mostly change of internal routines.	Process automation.
Prefabricated buildings	System innovation (technical).	Knowledge integration (knowledge of all trades is combined and integrated, producing industries).	High, because affecting division of labour.	High, because it affects the division of work between trades, requires new working procedures and overcomes the locality problem.	Industrialization.
Service business model	Product resp. Service innovation.	Cross-sector knowledge combination (construction, service).	Medium to high, because new market.	High, new actor constellations, reconfiguration of value chain.	System integration.
Building teams	Process innovation (communication and planning).	Knowledge integration (core part of sector and customer).	Medium, depending on trust.	Medium, new division of labour on inter-firm level but slow diffusion.	Network company.
ICT tools	Process innovation (communication and planning.	Knowledge needs to be explicated and newly combined to merge different sector-logics (ICT / construction).	High, because conflict with tacit knowledge.	Limited because of strong routines of tacit knowledge hindering broader level change.	Flexible standardization.

Source: own compilation

CHAPTER 7

Conclusion

7.1 Introduction

The central concern of this thesis was to analyse knowledge dynamics in innovation processes from a methodological and spatial perspective. Three aims have been formulated to guide research in a complementary manner. They referred to the research questions raised at the beginning of this thesis, namely "What are the characteristics of knowledge generation and application in innovation processes?", "How do knowledge dynamics evolve over time within the network of participating actors?", "How do knowledge dynamics emerge in light of different regional, national and global spatial scales from which the knowledge might originate?", "What sectoral conditions influence knowledge dynamics and social interaction in the process of innovation creation?"

The first aim required analysis of the intrinsic dimensions of knowledge dynamics, i.e. of their nature in innovation creation from idea to implementation; the second aim asked for substantiating the research approach of Innovation Biographies from a methodological and comparative perspective, and the third addressed the sectoral context dimension of knowledge dynamics in the tourism and construction sector. In this conclusion, findings relating to the three aims and the research questions will be discussed and synthesised.

7.2 Aim I: The Nature of Knowledge Dynamics

Research on the nature of knowledge dynamics was addressed by the following aim:

> "To analyse the nature of knowledge dynamics in innovation processes from idea to implementation according to content, actor constellations and the related micro-geography."

Analyses of this dissertation provided empirical evidence that the nature of knowledge dynamics in the studied innovation processes was essentially characterised by combinations of knowledge (Crevoisier and Jeannerat 2009, Strambach and Klement 2012) from different sectors and geographical scales. Knowledge about nanotechnology was combined with manufacturing knowledge (cp. chapter 4); production structures of the automotive industry influenced those of prefabricated houses (cp. chapter 6), football clubs of the German Bundes league cooperated with tourism actors and thereby stimulated innovation (cp. chapter 5).

A large variety of different actors have constituted the social networks by which the innovations have been developed. All innovation processes based on cooperation of at least two actors of the "triple-helix"[17] (Etzkowitz and Leydesdorff 2000), many rest on cooperation of all three, and some mirror the "quadruple helix" (Carayannis and Campbell 2009), involving customers as the fourth component of the helix. Especially public actors have played an important role in tourism and construction innovation processes, either as drivers of innovation or as actors balancing out risks (cp. chapter 5 and 6 and section 7.5 in this chapter).

Pre-existing social relations among actors have proven not to be a general precondition for being part of the social network developing the innovation (cp. in-depth analyses of innovation processes in chapter 4 and 5). Networks have rather been constituted by a mixture of actors known and unknown to the main innovating actor, in order to account for the explorative process and the arising novelty. The constitution of networks was often accompanied with intensive and complex search to find adequate partners. An important channel through which partners have been found was hearsay: problems and challenges connected to the innovations have been discussed with known actors and often resulted in the recommendation of second tier partners who

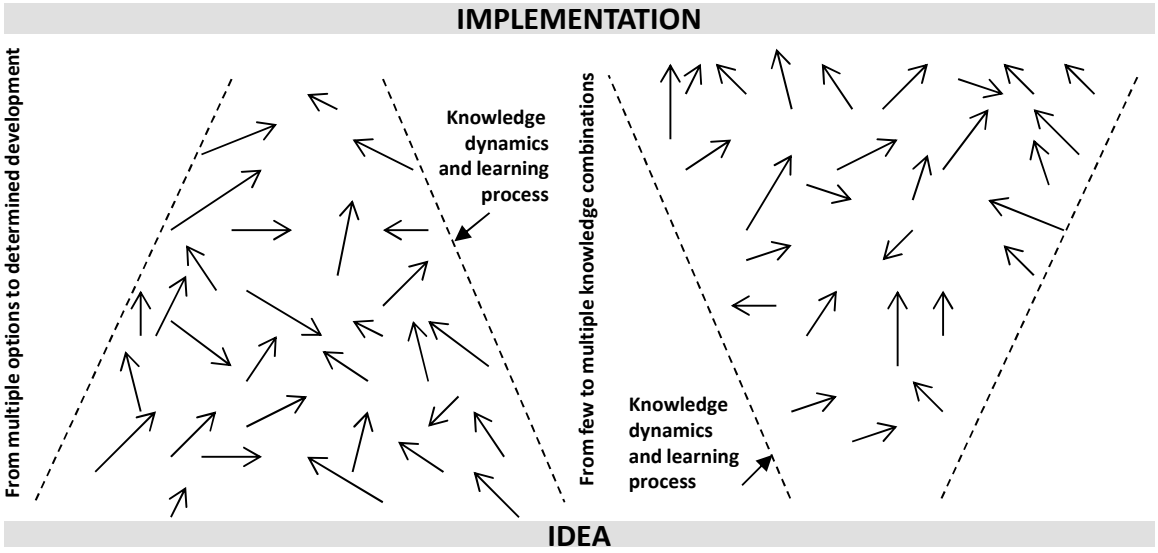
[17] i.e. research institutions, public and private actors.

were perceived as competent. Thus, the social network directly related to the innovation process co-evolved in accordance with the requirements of developing further the innovation, instead of being determined right from the beginning.

These empirical insights suggest that knowledge dynamics and related social interactions in concrete innovation processes are considerably determined through the problems/challenges arising due course. The most important criterion to select partners was their competence in solving these problems rather than pre-existing, trustful relations. Instead, more implicit dimensions of trust played a role, for example through reputation, recommendation, or trust in formal arrangements (Glückler and Armbrüster 2003), through which cooperation with unknown partners could be established.

By establishing a dynamic perspective on knowledge generation and knowledge combination, therefore, it is suggested to understand knowledge generation and learning as two differently shaped, but simultaneously evolving trajectories (cp. figure 9). The first innovative idea is diffuse and goes along with a broad variety of opportunities and interactions to develop it further. Over time, the trajectory becomes clearer, it is known what to do, which problems to solve and what will be the next tasks (also if each task in itself might be a complex problem). Concrete actions, even if as intensive as before, are channelled and concentrated and possibilities to redirect the trajectory decrease (first trajectory, from broad to narrowing down). In terms of knowledge combinations, evolvement has an inverted shape. Whereas the very first idea necessarily is discussed with limited number of people, the diversity of knowledge combinations adds up and increases with the furthering of the process (second trajectory, from a narrow frame to broadly based knowledge combinations). In this way of knowledge generation and learning, temporary spatial proximity (meetings, negotiations, conferences, fairs, etc.) seems to be important in facilitating the combination of diverse knowledge and the variety of knowledge transfer channels (cp. also Strambach and Klement 2012).

Figure 9: Knowledge Dynamics and Learning in Innovation Processes



Source: own illustration, with reference to Chesbrough 2003

The related micro-geography differed strongly within the studied innovation processes and there is no clear pattern of time-geographical aspects (e.g. an innovation process would start based on cooperation with regional actors and then stretch-out to national and international scales). However, it was found that none of the studied innovation processes was developed strictly by partners from one region. A detailed account of the geography of knowledge dynamics in the tourism and construction sectors will be given in the discussions related to the third aim (cp. section 7.5).

7.3 Aim II: The Research Approach of Innovation Biographies

Substantiating the research approach of Innovation Biographies was addressed by the following aim:

> "To explicate the research approach of Innovation Biographies and to embed it into the wider methodological array of economic geography, by assessing the value-added of its results in relation to other empirical approaches that analyse knowledge generation and social interaction in innovation."

To achieve the aim, Innovation Biographies have been explicated according to three conceptual building blocks and the concrete research procedure (cp. chapter 4). The building blocks are a "Knowledge-centred View based on the Micro-level", the "Open Exploration of Social Networks and their Evolution", and a "Biographical Time-space Perspective on Knowledge Generation". The building blocks have had crucial influence on the selection of tools constituting the research procedure.

The first building block, a "Knowledge-centred View based on the Micro-level" underpins the interest in knowledge dynamics through the selection of a concrete innovation event considered as the entry door to the practice of knowledge generation and application. The second building block, "Open Exploration of Social Networks and their Evolution" is operationalised by a narrative interview (Jovchelovitch and Bauer 2000) held with a person of central responsibility for an innovation process. This person is asked to reflect upon the development process from his/her perspective. Further interview partners are selected via snowball sampling. This procedure enables to trace actor networks and thereby to follow the unfolding of knowledge dynamics, independently from sectoral or administrative units. The third building block, a "Biographical Time-space Perspective on Knowledge Generation", is mirrored through triangulation of interview data, ego-centred network analysis (Wassermann and Faust 1994), where the innovation event itself is considered the "ego", document analysis and the construction of time-space paths. Thereby, the biography of an innovation event is reconstructed and triangulated (Flick 2011). Emphasis is put on newly generated, recombined and applied knowledge, the co-evolvement of the social network, actor constellations, and the multi-scalar reach of the innovation process.

With the key methodological principles of tracing the actors, the formation of social networks as well as following the development of the innovative idea, Innovation Biographies are complementary to other empirical approaches in economic geography. Complementarity can be illustrated by comparing Innovation Biographies with prominent empirical approaches and their related major research questions as shown in table 9. Selection criterion of the research approaches was their focus on knowledge, actors and social interactions in economic action, as common ground with Innovation Biographies.

Table 9: Innovation Biographies compared to main Methodological Approaches in Economic Geography

Empirical Approach	Social network analysis	Mixed-method approaches in regional analysis	Patent analyses	Ethnographies, mixed-methods	Innovation Biographies
Main research interest in economic geography	Forms of proximity, relational approaches	Regional Innovation Systems, TIMs	Regional and sectoral specialisation	Global production networks	Knowledge dynamics
Main Research Question	What are the structural characteristics of social relations in economic action?	What are socio-cultural and economic factors of regional innovation generation?	Who are the inventors and applicants in spatial / technological units?	What are the power relations and social interaction of global production and consumption?	How do knowledge dynamics evolve in multi-scalar and cross-sector interactions?
Data acquisition and key methodological principle	Surveys (e.g. of companies) or data bases (e.g. related to R&D), codification and analysis of social links.	Analysis of regional statistics, expert interviews, surveys.	Analysis of data related to the patent application.	In-situ research (participant observation, narratives).	Follow the innovation idea by analysing interactions of actors involved.
Static / procedural	Static analyses, but emerging process orientation.	Static.	Static.	Process analyses.	Process analyses.
Deductive / inductive	Deductive.	Descriptive/inductive.	Deductive.	Inductive.	Inductive.
Spatial level	Depending on reach of network, from regional to international scales.	Regional.	From local to global.	In-depth analysis of the global connectedness of industries.	Concrete innovation events, from local to global.

Source: own compilation

As table 9 illustrates, Innovation Biographies differentiate from other research approaches by having the focus on a concrete innovation event and by applying a process perspective through which an innovation event is studied. This focus is mirrored on a content-level through the interest in knowledge dynamics and social networks at the micro-scale; on a method-level through the selection of appropriate research instruments allowing to grasp processes, (the narrative interview, snowball sampling and time-space paths); and

on a methodological level through which the research process as a whole is kept flexible and each step is being defined through the outcomes of the previous rather than being determined from the beginning (e.g. it depends on the case itself how many interviews need to be held before it is sufficiently understood).

With these characteristics, Innovation Biographies can be linked to the approach of grounded theory building (Glaser and Strauss 1967). Grounded theory building as a research paradigm was developed to perceive theory not as an ends in itself, but first and foremost regarding its meaning for practice (Alheit 1999/2000). Thereby it was also meant to be an alternative draft to the "grand theories" of social sciences that more and more disconnected from social reality. Grounded theory building is a qualitative research approach which strives to inductively generate new knowledge through empirical research. As in Innovation Biographies, the selection of methods in grounded theory research follows the key principle of enabling to grasp *process and change*: "Since phenomena are not conceived as static but as continually changing in response to evolving conditions, an important component of the method is to build change, through process, into the method" (Corbin and Strauss 1990: 5).

Therewith, Innovation Biographies allow substantially enriched insights in the causalities and interdependencies arising in innovation creation (cp. chapter 4). Apart from the (1) provision of detailed accounts of the dynamics of knowledge generation in innovation development, actor constellations and spatial scope; and (2) the complementary micro-level and process-perspective; further advantages of Innovation Biographies are the (3) enabled analysis of cross-sectoral relations emerging on multiple territorial scales since the research process is not limited by administrative or sectoral borders; and, (4) through the standardised set of research instruments, Innovation Biographies enable sound cross-case comparisons.

Drawbacks are related to (1) fuzziness about the question when an innovation process starts and ends?; (2) to the strong reliance on interviews and potentially related biases regarding the likeliness to reflect only on successful innovation cases rather than on failed ones; (3) to the difficulty to select

meaningful cases; and (4) to the risk of providing an isolated picture of the innovation process provoked by the micro-level perspective (cp. also chapter 4). These limitations need also to be considered when interpreting results of this thesis.

7.4 Aim III: The Context of Knowledge Dynamics in Tourism and Construction

The context dimension of knowledge dynamics in tourism and construction was addressed by the following aim:

> "To study sectoral innovation specifics within tourism and construction by analysing the mutual influence of knowledge dynamics and the geographical and social context in concrete innovation processes, and by interpreting findings in light of the sectors' particular distinctions."

Spatial distinctions of the tourism sector heavily influence knowledge dynamics and innovation behaviour (cp. chapter 5). Especially the density of tourism service providers causes massive competition. They are bound to a limited geographical area in terms of both, the production and consumption of their services (Hall and Williams 2008). Possibilities of market expansion are limited. Furthermore, because of the high visibility of innovations and the underdeveloped mechanisms to protect intellectual property, innovations are imitated at frequent rate (Sørensen 2007).

Two types of innovation strategies, namely "assimilation" and "distinction" that strive to counteract competition in tourism have been empirically elaborated further as compared to earlier research (Butzin 2012b). In the "assimilation" strategy, proximate actors are involved in knowledge generation. By incorporating actors that otherwise could be potential competitors, a lever is installed to prevent imitation. The geography of knowledge dynamics thus, has a strong regional emphasis, though national and even international interactions do take place. The "assimilation" strategy is foremost applied in the studied innovation processes taking place in Northern Europe, i.e. in coun-

tries where tourism does not belong to the sectors with major importance. The second strategy is labelled "distinction". Within this strategy, competitive advantage is achieved through the incorporation of actors into the process of knowledge generation who are located in other countries. Utilising internationally sourced, for others not easily accessible knowledge allows innovators to develop unique services that cannot be immediately imitated by others. The spatial stretch out of knowledge dynamics is much more internationalised than in the strategy of "assimilation". The "distinction" strategy is applied in the studied Turkish innovation processes, i.e. innovation processes that have been carried out in a context in which tourism is a major component of economic growth.

The innovation-related learning routines of tourism actors are thus influenced by spatial distinctions of the innovations' contexts. Apart from this commonality learning routines, however, show different characteristics (cp. the assimilation/distinction strategies). Furthermore, what is striking is the intensive involvement of public actors in innovation processes carried out under the "assimilation" strategy. With respect to knowledge generation, public actors have mostly been involved in core parts of development, i.e. when the innovative idea was brought forward in a substantive way. Public actors can hence be labelled as an innovation driver in the studied innovation processes. In the "distinction" strategy, these core parts of development have mainly been progressed by incorporating private actors from international scales.

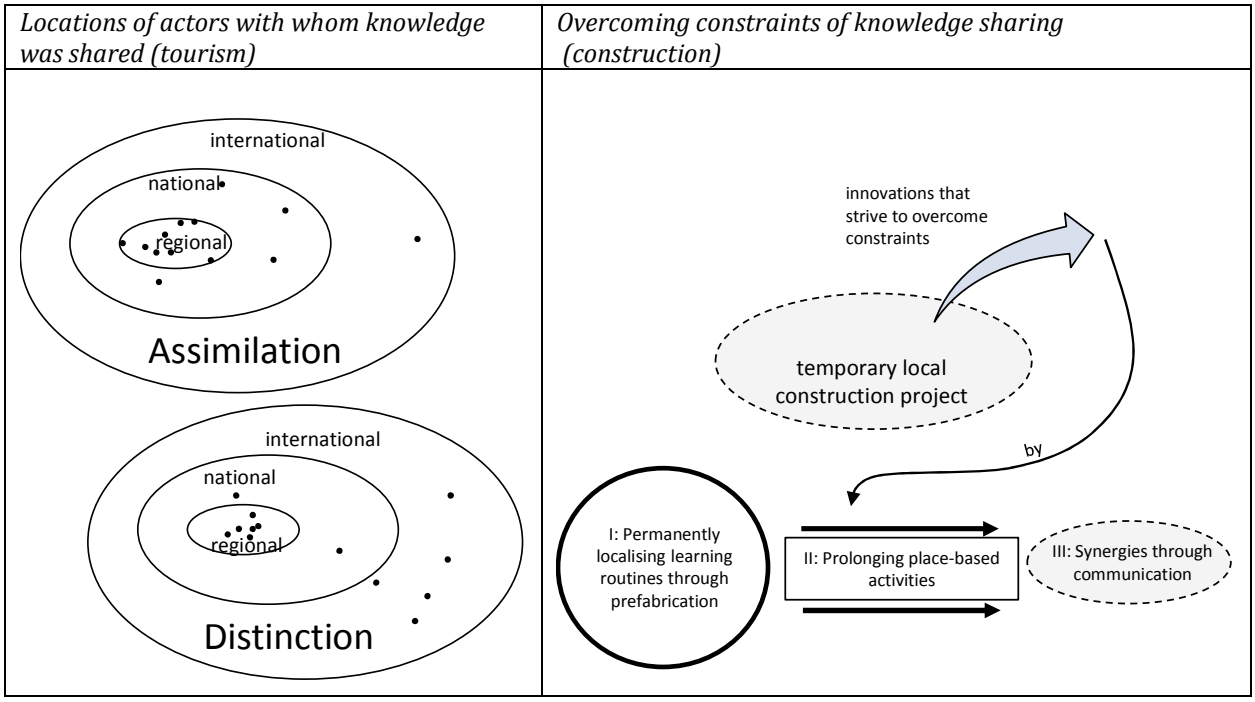
The construction sector is characterised through temporary, spatially bounded and project-based structures that result in renewed knowledge generation in every single building project. Though ever new projects, challenges and actor constellations favour the frequent emergence of knowledge through novel ideas, processes and organisational features, the strongly localised "projectification" at the same time hinders knowledge transfer across projects (Kadefors 1995). Current innovation strategies strive to overcome these drawbacks, in particular through changing or prolonging place-based production structures with the aim to enable establishment of learning routines. These strategies are prefabrication in permanent production halls allowing the long-term formation of working routines at a fixated location; increased

service-orientation and a prolonged production chain (i.e. planning, construction, and facility management offered by the same firm) through which location-related actions are expanded; or through modifying communication structures and cross-trade team building to achieve synergies. These innovation strategies are crucially influenced by knowledge combinations from the automotive and service sectors, as well as from ICT sectors.

Moreover, as in the studied innovation processes of Northern Europe's tourism sector, public actors played distinctive role in the innovation processes of the construction sector. They fulfilled the function of balancing out high risks connected to parts of the innovation processes, e.g. they provided opportunity for pilot actions, or were in charge of carrying out long-term test-phases of new materials that would have been too costly for private actors.

Spatial distinctions related to knowledge generation in the tourism (i.e. assimilation and distinction) and in the construction sector (overcoming constraints of local boundedness and temporality in construction projects) are illustrated in figure 10.

Figure 10: The Spatiality of Knowledge Dynamics in Tourism and Construction



source: own illustration

7.5 Policy implications

Starting point of policy implications are the studied combinatorial and multi-scalar nature of knowledge dynamics, as well as the co-evolving character of the network of innovation actors. The most appropriate level of policy support for which findings of this thesis can be operationalised are measures to advance innovation in the tourism and construction sectors through knowledge sharing. Considerations outlined below should be seen in this light. However, due to the theoretical and methodological emphasis of this thesis, it would be a future task to discuss, further develop and test these policy implications with relevant practitioners.

A suggestion is to include the option of a "*partner wildcard*" in project proposals. The suggestion addresses authorities setting up structures for funding innovation projects. A wildcard would allow the integration of additional partners into the project consortium in later stages of the project. Thereby, the project consortium would not be dependent on the constellation of actors, hence their knowledge, formed in an early stage. Rather, knowledge that turned out to be of relevance due course can be accessed and shared to advance the innovation project.

A further suggestion concerns initiation of "*multi-scalar knowledge sharing*" across funded innovation projects through the organisation of dedicated events. It addresses local economic development agencies. The events would take place at local level and target at all participants of the local area, who are currently active in tourism or construction innovation projects, independently from the funding authority. Through the event a frame is provided, enabling knowledge sharing between locally funded projects, national and European projects, etc. Hence, insights of international innovation projects are shared with other local actors; and insights of local projects inform participants of international projects.

Especially in the studied innovation processes of the tourism sector, "*public sector actors as innovation drivers*" have played significant role. In order to underpin and increase awareness of this powerful function, dedicated measures can be initialized. Measures can have various formats such as (international) forums at which public sector actors can share related experi-

ence and knowledge. Furthermore, knowledge about public actors in tourism innovation processes can be substantiated through future applied research projects.

7.6 Suggested Directions for Future Research

This thesis followed two intentions of different nature. The first was content-related and strived to shed light on the nature and spatial characteristics of knowledge dynamics applied in innovation processes. The second was methodological and strived to underpin the research approach of Innovation Biographies.

With respect to future research, therefore, there are many more content-related opportunities to apply Innovation Biographies as could be exercised in this thesis. This especially regards to more systematic analyses of innovation processes in thematic areas, e.g. clusters, specific regional contexts, or knowledge bases, innovation processes characterised by customer integration, innovations initiated by citizens, public services, universities, etc. Such studies would provide relevant results for specific communities be they scientific (e.g. the large community on researchers of clusters), or practice oriented (e.g. cluster managers and local economic development agencies).

Furthermore, it seems promising to put focus on the time dimension installed in Innovation Biographies. In this research, time was utilised as a lever to grasp the unfolding of knowledge dynamics rather than as an analytical category. In the future, questions analysing the kind of knowledge generated in early, middle and late stages of developments, patterns of changing actor constellations and the related spatiality, or systematic comparisons of network evolution over time could be addressed more directly.

A third aspect relates to the potential of embedding the Innovation Biography approach with its micro-perspective into research frameworks connecting micro-, meso-, and macro-levels through a multi-level perspective (Geels 2002), and thereby grasp societal and/or technological transformations in an holistic way from small scale events to broad configuring structures.

References

Alheit, P. (1999/2000): „Grounded Theory“: Ein alternativer methodologischer Rahmen für qualitative Forschungsprozesse. Göttingen. http://www.fallarchiv.uni-kassel.de/wp-content/uploads/2010/07/alheit_grounded_theory_ofas.pdf (accessed on 08.11.2013)

Amin, A. and Cohendet, P. (2004): Architectures of Knowledge. Oxford University Press. Oxford. New York.

Amin, A. and Thrift, N. (1992): Neo-Marshallian nodes in global networks. In: International Journal of Urban and Regional Research, 16: 571-87.

Architektenkammer Baden Württemberg (Ed.) (2009): Bauteam – Ein Leitfaden für Architekten und Handwerker. http://www.akbw.de/fileadmin/download/dokumenten_datenbank/AKBW_Broschueren/Bauherreninformationen/Bauteam-Leitfaden_ergaenzt.pdf. (accessed 24.04.2012).

Asheim B.T., Boschma, R. and Cooke, P. (2011): Constructing Regional Advantage: Platform Policies Based on Related Variety and Differentiated Knowledge Bases. Regional Studies 45/7: 893-904.

Asheim, B. and Coenen, F. (2005): Knowledge Bases and Regional Innovation Systems: Comparing Nordic Clusters. In: Research Policy 34: 1173-1190.

Asheim, B. and Gertler, M. (2005): The Geography of Innovation. In: Fagerberg, J., Mowery, D. and Nelson, R. (eds.): The Oxford Handbook of Innovation. Oxford University Press. New York: 291-317.

Asheim, B.T. (1999): Interactive learning and localised knowledge in globalising learning economies. In: GeoJournal, 49: 345-52.

Asheim, B.T. (2007): Differentiated Knowledge Bases and varieties in Regional Innovation Systems. In: Innovation – The European Journal of Social Science Research, 20(3): 223-241.

Audretsch D.B. and Feldman M.P. (2004): Knowledge Spillovers and the Geography of Innovation. In: Henderson, J.V. and Thisse, J.-F. (2004): Handbook of Regional and Urban Economics. Volume 4 Cities and Geography, Elsevier North Holland: 2713–2739.

Bathelt, H. and Glückler, J. (2003): Toward a relational economic geography. Journal of Economic Geography 3, 117-144

Balland, P.A. (2012): Proximity and the Evolution of Collaboration Networks: Evidence from Research and Development Projects within the Global Navigation Satellite System (GNSS) Industry. Regional Studies 46 (6): 741-756.

Balland, P.A., Boschma, R. and Frenken, K. (2013a): Proximity and Innovation Networks: An Evolutionary Approach. In: P. Cooke (ed.): Re-framing Regional Development: Evolution, Innovation and Transition. Routledge, New York: 186-200.

Balland, P.A., De Vaan, M. and Boschma, R. (2013b): The dynamics of inter-firm networks along the industry life cycle: The case of the global video game industry, 1987–2007. In: Journal of Economic Geography, 2013: 741-765.

Bathelt, H., Malmberg, A. and Maskell, P. (2004): Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. Progress in Human Geography, 28(1): 31-56.

Becattini, G. (2004); Industrial Districts. A new Approach to Industrial Change. Edward Elgar. Cheltenham.

Bestor, T. (2005):How Sushi went global. In: Watson, J. and Caldwell, M (eds): The cultural politics of food and eating: a reader, Oxford, Blackwell.

Bieger, T. and Weinert, R. (2006): On the nature of the innovative organization in tourism: Structure, process, results. In: Walder, B., Weiermaier, K. and Sancho Pérez, A. (eds): Innovation and Product development in tourism. Creating Sustainable Competitive Advantage. Erich Schmidt Verlag, Berlin: 88-102.

Bien-Zenker GmbH (2011): Geschäftsbericht 2011. http://www.bien-zenker.de/uploads/media/Bien-Zenker_GB_2011.pdf (24.09.2012).

Biernacki, P. and Waldorf, D. (1981): Snowball Sampling. Problems and Techniques of chain referral sampling. In: Social Methods and Research 10 (2): 141-163.

Blacker, F. (2002): Knowledge, Knowledge Work, and Organizations. In: Choo, C.W. and Bontis, N. (eds.): The Strategic Management of Intellectual Capital and Organizational Knowledge. Oxford University Press. New York: 47-62.

Bosch, G. and Zühlke-Robinet, K. (1999): Der Bauarbeitsmarkt in Deutschland. Zum Zusammenhang von Produktionsstrukturen, Arbeitsmarkt und Regulierungssystem. In: Industrielle Beziehungen, 6(3): 239-266.

Boschma, R. (2005): Proximity and Innovation: A critical Assessment. Regional Studies 39.1: 61-74.

Braczyk, H.-J., Cooke, P. and Heidenreich, M. (1998): Regional Innovation Systems. The Role of Governances in a Globalized World. Routledge.

Breschi, S. and Lissoni F. (2001): Knowledge Spillovers and Local Innovation Systems. A critical survey. In: Liuc Papers no. 84. Serie Economia e Impresa: 1-30. http://www.biblio.liuc.it/liucpap/pdf/84.pdf (21.09.2013)

Breschi, S. and Lissoni, F. (2009): Mobility of skilled workers and co-invention networks: an anatomy of localized knowledge flows. In: Journal of Economic Geography, 9(4): 439-468.

Broekel, T. (2012): The co-evolution of proximities – a network level study. Papers in Evolutionary Economic Geography #11.17. http://econ.geo.uu.nl/peeg/peeg.html (22.09.2013)

Bruns, E., Ohlhorst, D., Wenzel, B. and Köppel, J. (2009): Erneuerbare Energien in Deutschland. Eine Biographie des Innovationsgeschehens. Universitätsverlag der TU Berlin.

Bunell, T. and Coe, N.M. (2001): Spaces and Scales of Innovation. Progress in Human Geography. 25, 4 (2001): 596-589.

Butzin, A. (2009): Innovationsbiographien als Methode der raum-zeitlichen Erfassung von Innovationsprozessen. In: Dannenberg, Peter et al. (Eds.): Innovationen im Raum – Raum für Innovationen: 11. Junges Forum der ARL. Hannover: Akademie für Raumforschung und Landesplanung: 189-198.

Butzin, A. (2012a): Aufbau und Forschungsprozess von Innovationsbiographien. In: Butzin, A., Rehfeld, D. and Widmaier, B. (Eds.): Innovationsbiographien. Räumliche und sektorale Dynamik. Nomos Verlag. Baden-Baden: 123-137.

Butzin, A. (2012b): Wissensdynamiken und Innovationsstrategien im Tourismussektor: eine Studie mit Innovationsbiographien. In: Butzin, A., Rehfeld, D. and Widmaier, B. (Eds.): Innovationsbiographien. Räumliche und sektorale Dynamik. Nomos Verlag. Baden-Baden: 179-198.

Butzin A. and Rehfeld, D. (2013): The balance of change and continuity in the German construction sector's development path. Zeitschrift für Wirtschaftsgeographie (57): 15-26.

Butzin, A. and Rehfeld, D. (2009): Innovationsbiographien in der Bauwirtschaft. Abschlussbericht. Fraunhofer IRB Verlag (Forschungsinitiative Zukunft Bau, 2718). Stuttgart.

Butzin, A. and Widmaier, B. (2012): The study of time-space dynamics of knowledge with innovation biographies. Working paper on innovation and space, no. 07/12, Department of Geography, Philipps-University Marburg

Butzin, A., Rehfeld, D. and Widmaier, B. (eds.)(2012): Innovationsbiographien. Räumliche und sektorale Dynamik. Nomos Verlag, Baden Baden.

Camagni, R. (1991): Innovation networks: Spatial Perspectives. Belhaven Press. London and New York.

Carayannis, E.G. and Campbell, D. (2009): 'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem. In: International Journal of Technology Management, 46(3-4): 201-234.

Carrillo, P., Harding, J. and Choudhary, A. (2011): Knowledge discovery from post-project reviews. In: Construction Management and Economics, 29(7): 713-723.

Carrincazeaux C. and Coris M. (2011): Proximity and Innovation. In: Cooke, P., Asheim, B., Boschma, R., Martin, R., Schwartz, D. and Tödtling, F. (eds.): Handbook of Regional Innovation and Growth. Edward Elgar, London: 269-281.

Chamberlayne, P., Bornat, J. and Wengraf, T. (eds.) (2000): The Turn to Biographical Methods in Social Sciences. Taylor and Francis, Routledge, London.

Chesbrough, H.W. (2003): Open Innovation: The new imperative for creating and profiting from technology. Harvard Business School Press. Boston.

Coe, N.M., Dicken, P. and Hess M. (2008): Introduction – global production networks, debates and challenges. Journal of Economic Geography 8: 267-269.

Cohen, W.M. and Levinthal, D.A. (1990): "Absorptive capacity: A new perspective on learning and innovation", *Administrative Science Quarterly*, Vol. 35, Issue 1: 128-152.

Cook, I. et al. (2006): Geographies of food: following. Progress in Human Geography 30, 5: 655-666.

Cook, I., Crang, P. and Thorpe, M. (1998): Biographies and geographies: consumer understandings of the origins of food. British Food Journal 100/3: 162-167.

Cooke, P. (1998): Introduction: Origins of the Concept. In: Braczyk, H.-J., Cooke, P. and Heidenreich, M. (eds.): Regional Innovation Systems. The role of Governances in a Globalized World. UCL Press. London: 2-25.

Cooke, P. and Kaiser, R. (2012): Innovationsbiographien in öffentlichen und privaten Forschungskontexten am Beispiel der Biotechnologie. In: Butzin, A., Rehfeld, D. and Widmaier, B. (2012): Innovationsbiographien. Räumliche und sektorale Dynamik. Nomos-Verlag. Baden-Baden.

Cooper, C. (2006): Knowledge management and tourism. Annals of Tourism Research 33(1): 47-64.

Crang, M. (2002): Qualitative methods: the new orthodoxy? Progress in Human Geography 26/5, 647-655.

Crang, P. (2005): Local-Global. In: Cloke, P., Crang, P. and Goodwin, M. (eds): Introducing human Geographies (second edition). London, Arnold: 34-50.

Crevoisier, O. and Jeannerat, H. (2009): Territorial Knowledge Dynamics: From the Proximity Paradigm to Multi-location Milieus. In: European Planning Studies, 17(8), Routledge: 1223-1242.

Dolata, U. (2008): Technologische Innovationen und sektoraler Wandel. Eingriffstiefe, Adaptionsfähigkeit, Transformationsmuster: Ein analytischer Ansatz. In: Zeitschrift für Soziologie 37 (1), 42-59.

Döring, T. and Schnellenbach, J. (2006): What Do We Know about Geographical Knowledge Spillovers and Regional Growth?: A Survey of the Literature. In: Regional Studies, 40(3): 375-395.

Dosi, G. (1988): Technical change and economic theory. Pinter (IFIAS research series, 6). London.

Dubois, A. and Gadde, L.E. (2002): The construction industry as loosely coupled system: implications for productivity and innovation. In: Construction Management and Economics 20: 621-631.

Edquist, C. and Johnson, B. (1997): Institutions and Organizations in Systems of Innovation. In: Edquist, C. (Ed.): Systems of Innovations. Technologies, Institutions and Organisations. Pinter. London, Washington: 41-64.

Ekstedt, E., Lundin, R. and Wirdenius, H. (1992): Conceptions and Renewal in Swedish Construction Companies. In: European Management Journal, 10(2): 202-209.

Engwall, M. (2003): No Project is an Island: Linking Projects to history and context. In: Research Policy, 32(5): 789-808.

Etzkowitz, H. and Leydesdorff, L. (2000): The Dynamics of Innovation: From National Systems and 'Mode 2' to a Triple Helix of University-Industry-Government Relations. Research Policy, 29(2): 109-123.

Etzkowitz, H. and Leydesdorff, L. (2001): The dynamics of innovation: from National Systems and “mode 2” to a Triple Helix of university-industry-government relations. In: Reearch Policy, 29: 109-123.

Fielding, N.G. and Fielding, J.L. (1986): Linking Data. Beverly Hills. Sage.

Fischer-Rosenthal, W. and Rosenthal G. (1997): Warum Biographieanalyse und wie man sie macht. In: Zeitschrift für Sozialforschung und Erziehungssoziologie. Heft 17: 405-427.

Flagestad, A. (2006): The destination as an innovation system for non-winter tourism In: Walder, B., Weiermaier, K. and Sancho Pérez, A. (eds): Innovation and Product development in tourism. Creating Sustainable Competitive Advantage. Erich Schmidt Verlag. Berlin: 26-38.

Flick, U. (2011): Triangulation. Eine Einführung. VS Verlag für Sozialwissenschaften. Wiesbaden.

Frenken, K., Van Ort, F. and Verburg, T. (2007): Related Variety, Unrelated Variety and Regional Economic Growth. In: Regional Studies, 41(5): 685-697.

Fromhold-Eisebith, M. (1995): Das „kreative Milieu" als Motor regionalwirtschaftlicher Entwicklung. Forschungstrends und Erfassungsmöglichkeiten. In: Geographische Zeitschrift, 83(1): 30-47.

Fuchs-Heinritz, W. (2005): Biographische Forschung. Eine Einführung in Praxis und Methoden. 3. überarbeitete Auflage. Hagener Studientexte zur Soziologie. VS Verlag für Sozialwissenschaften. Wiesbaden.

Gabel, T. and Boller, G. (2003): A preliminary look at the globalization of the tortillas in Mexico. In: Advances in Consumer Research, 30: 135-142.

Gann, D.M. and Salter, A.J. (2000): Innovation in project-based, service-enhanced firms: the construction of complex products and systems. In: Research Policy 29(7-8): 955-972.

Gebauer, H., Bravo-Sanchez, C. and Fleisch, E. (2008): Service strategies in product manufacturing companies. In: Business Strategy Series, 9(1): 12-20.

Geels, F.W. (2002): Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. In: Research Policy, 31 (8-9): 1257-1274.

Gerich, J. and Lehner, R. (2003): Egozentrierte Netzwerkerhebung mittels selbstadministrierter Computerinterviews. In: Österreichische Zeitschrift für Soziologie, Heft 28, Nr. 4: 46-70.

Gertler, M.S. and Levitte, Y.M. (2005): Local Nodes in Global Networks: The Geography of Knowledge Flows in Biotechnology Innovation. In: Industry and Innovation 12: 487-507.

Gertler, M.S., and Levitte, Y.M. (2005): Local nodes in global networks: The geography of knowledge flows in biotechnology innovation. In: Industry and Innovation, 12: 487-507

Gidado, K.I. (1996): Project complexity: The focal point of construction production planning. In: Construction Management and Economics, 14: 213-225.

Giuliani, E. 2011: Networks of Innovation. In: Cooke, P., Asheim, B., Boschma, R., Martin, R. and Schwartz, D. (eds.) (2011): Handbook of Regional Innovation and Growth. E. Elgar Publishing Ltd. 155-166.

Glaser, B.G. and Strauss, A. (1967): Discovery of Grounded Theory. Strategies for Qualitative Research. Sociology Press.

Glaser, B.G. and Strauss, A.L. (1967): The discovery of Grounded Theory. Strategies for Qualitative Research. The Sociology Press. Mill. Valley.

Glückler, J. (2007): Economic geography and the evolution of networks. In: Journal of Economic Geography, 7: 619-634.

Glückler, J. and Armbrüster, T. (2003): Bridgin Uncertainty in Management Consulting: The Mechanisms of Trust and Networked Reputation. In: Organization Studies, 24(2): 269-297.

Grabher, G. (2002): Cool Projects, Boring Institutions: Temporary Collaboration in Social Context. In: Regional Studies, 36(3): 205-214.

Grabher, G. (2004): Temporary Architectures of Learning: Knowledge Governance in Project Ecologies. In: Organization Studies, 25(9): 1491-1514.

Grabher, G. (2009): Yet Another Turn? The Evolutionary Project in Economic Geography. In: Economic Geography, 85(2): 119-127.

Grabher, G.; Ibert, O. and Flohr, S. (2008): The Neglected King: The Customer in the New Knowledge Ecology of Innovation. Economic Geography 84 (3): 253-280.

Hägerstrand, T. (1967): Innovation Diffusion as a Spatial Process (Innovationsförloppet ur korologisk synpunkt, original published 1953). Chicago: University of Chicago Press.

Hägerstrand, T. (1987): The Space of Time and the Order of Things. In: Om tidens vidd och tingens ordning: Texter av Torsten Hägerstrand. Edited by G. Carlestam and B. Sollbe. Byggforskningsradet. Stockholm.

Halkier, H. and Therkelsen, A. (2013): Exploring Tourism Destination Path Plasticity. The Case of Coastal Tourism in North Jutland, Denmark. In: Zeitschrift für Wirtschaftsgeographie, 1-2, 2013: 39-51.

Halkier, H., James, L., Dahlström, M. and Manniche, J. (2012): Knowledge Dynamics, Regions, and Public Policy. In: European Planning Studies, 20(11): 1759-1766.

Hall, M.C. and Williams, A.M. (2008): Tourism and Innovation. Routledge. London and New York.

Hallin, C.A. and Marnburg, E. (2008): Knowledge management in the hospitality industry: A review of empirical research. In: Tourism Management 29(2): 366-381.

Healy, A. and Morgan, K. (2012): Spaces of Innovation: Learning, Proximity and the Ecological Turn. In: Regional Studies 46(8): 1041-1053.

Henriksen, P.F. and Halkier, H. (2009): From Local Promotion towards Regional Tourism Policies: Knowledge Processes and Actor Networks in North Jutland, Denmark. In: European Planning Studies 17(10): 1445-1462.

Hjalager, A.M. (2002): Repairing innovation defectiveness in tourism. In: Tourism Management, 23: 465-474.

Hjalager, A.M. (2010): A review of innovation research in tourism. Tourism Management, 31: 1-12.

Holm, M.G. (2000): Service management in housing refurbishment: a theoretical approach. In: Construction Management and Economics, 18(5): 525-533.

Homepage AAL Deutschland: http://www.aal-deutschland.de/ (13.01.2013)

Howells, J. (2002): Tacit Knowledge, Innovation and Economic Geography. Urban Studies 39(5-6): 871-884.

Howells, J. (2012): The geography of knowledge: never so close but never so far apart. Journal of economic geography 12: 1003-1020.

Howells, J. (2012): The geography of knowledge: never so close but never so far apart. Journal of economic geography, 12: 1003-1020.

Hudson, R. (2003): Fuzzy Concepts and Sloppy Thinking: Reflections on Recent Developments in Critical Regional Studies, 37(6-7): 741-746.

Ibert, O. (2007): Towards a Geography of Knowledge Creation: The Ambivalences between “Knowledge as an Object” and “Knowing in Practice”. In: Regional Studies, 41(1): 103-114.

Ibert, O. (2010): Relational distance: Socio-cultural and time-spatial tensions in innovation practices. In: Environment and Planning A 42/1: 187-204.

Jacobs, J. (1969): The Economy of Cities. Vintage. New York.

Jaffe, A.B., Trajtenberg, M. and Henderson, R. (1993): Geographic localization of knowledge spillovers as evidenced by patent citations. In: Quarterly Journal of Economics, 108(3): 577-598.

Jansen, D. (1999) Einführung in die Netzwerkanalyse: Grundlagen, Methoden, Anwendungen. Leske+Budrich, Opladen.

Jennings, W. (2012): Why costs overrun: risk, optimism and uncertainty in budgeting for the London 2012 Olympic Games. In: Construction Management and Economics, 30 (6): 455-462.

Jensen, M.B., Johnson, B. and Lundvall, B.A. (2007): Forms of knowledge and modes of innovation. In: Research Policy, 36: 680-693.

Jovchelovitch, S. and Bauer, M. (2000) Narrative interviewing. LSE Research Online. Available at: http://eprints.lse.ac.uk/2633

Kadefors, A. (1995): Institutions in building projects: implications for flexibility and change. In: Scandinavian Journal of Management, 11(4): 395-408.

Kash, D.E. and Auger, R.N. (2005): From a few craftsmen to an international network of alliances: Bosch Diesel fuel injection systems. In: International Journal of Innovation Management, 9/1: 19-45.

Kline S. and Rosenberg N. (1986): An Overview of Innovation. In: Landau, R. and Rosenberg, N. (Eds.): The Positive Sum Strategy: Harnessing Technology for Economic Growth. National Academies Press.: 275-305.

Krätke, S. (2010): Regional Knowledge Networks: A Network Analysis Approach to the Interlinking of Knowledge Resources. In: European Urban and Regional Studies, 17(1): 83-97.

Krugman, P. (1991): Geography and Trade. Cambridge (MA), MIT Press.

Lagendijk, A. (2003): Towards Conceptual Quality in Regional Studies: The Need for Subtle Critique – A Response to Markusen. In: Regional Studies, 73(6-7): 719-727.

Larsen, G.D. (2011): Understanding the early stages of the innovation diffusion process: awareness, influence and communication networks. In: Construction Management and Economics, 29(10): 987-1002.

Latour, B. (1987): Science in Action: How to Follow Scientists and Engineers Through Society. Milton Keynes: Open University Press

Leiringer, R. and Bröchner, J. (2010): Editorial: service-led construction projects. In: Construction Management and Economics, 28 (11): 1123-1129.

Lindkvist, L. (2005): Knowledge Communities and Knowledge Collectivities: A Typology of Knowledge Work in Groups. In: Journal of Management Studies, 42 (6): 1189-1210.

Lowe, M.A., Williams, A.M., Shaw, G. and Cudworth, K. (2012): Self-organizing innovation networks, mobile knowledge carriers and diasporas: insights from a pioneering boutique hotel chain. In: Journal of Economic Geography, 12: 1113-1138.

Lundvall, B.-Å. and Johnson, B. (1994): The learning economy. In: Journal of Industry Studies, 1(2): 23-42.

Malecki, E. (2010): Everywhere? The geography of knowledge. In: Journal of Regional Science, 50(1): 493-513.

Manniche, J. (2012): Combinatorial Knowledge Dynamics: on the Usefulness of the Differentiated Knowledge Bases Model. European Planning Studies 20(11). 1823-1841.

Manley, K. and Mcfallan, S. (2006): Exploring the drivers of firm-level innovation in the construction industry. In: Construction Management and Economics, 24(9): 911-920.

Markusen, A. (1999): Fuzzy Concepts, Scanty Evidence, Policy Distance: The Case for Rigour and Policy Relevance in Critical Regional Studies, 33(9): 869-884.

Maskell, P. (2001): The Firm in Economic Geography. In: Economic geography, publ. by Clark University (Worcester, Mass.), vol. 77-4. Clark University: 329-344.

Maskell, P. and Malmerg, A. (1999): Localised learning and industrial competitiveness. In: Cambridge Journal of Economics, (23): 167-185.

Maskell, P., Bathelt, H. and Malmberg, A. (2006): Building global knowledge pipelines: The role of temporary clusters. In: European Planning Studies, 14(8): 997-1013.

Miles, M. and Crush, J. (1993): Personal Narratives as Interactive Texts: Collecting and Interpreting Migrant Life-Histories. In: Professional Geographer, 45/1: 85-94.

Mingers J. and Brocklseby J. (1997): Multimethodology: Towards a Framework for Mixing Methodologies. In: Omega, International Journal of Management Science, 25(5): 489-509.

Moodysson J., and Jonsson, O. (2007): Knowledge Collaboration and Proximity: The Spatial Organization of Biotech Innovation Projects. In: European Urban and Regional Studies, 14 (2), 115-131.

Moulaert, F. and Sekia, F. (2003): Territorial Innovation Models: a Critical Survey. In: Regional Studies 2003, vol. 37.3: 289-302.

Nonaka, I. and Takeuchi, H. (1995): The knowledge-creating company. New York: Oxford University Press.

Nordhause-Janz, J., Rehfeld, D. and Welschhoff, J. (2011): Innovationsstrategien am Bau im internationalen Vergleich. BMVBS-Online-Publikation 07/11.

Oinas, P. and Malecki, E. (2002): The Evolution of Technology in Time and Space: From National and Regional Innovation Systems to Spatial Innovation Systems. In: International Regional Science Review 25(1): 102-131.

Oliva, R. and Kallenberg, R. (2003): Managing the transition from products to services. In: International Journal of Service Industry Management 14 (2): 160-172.

Orlikowski, W. (2002): Knowing in Practice: Enacting a Collective Capability in Distributed Organizing. Organization Science, 13(3): 249-273.

Paraskevas, A., Altinay, L., McLean, J. and Cooper, C.P. (2013): Crisis Knowledge in Tourism: Types, Flows and Governance. In: Annals of Tourism Research 41: 130-152.

Patton, M. (2002): Qualitative Research and Evaluation Methods. Sage Publications. Thousand Oaks. London.

Pechlaner, H., Fischer, E. and Hammann, E.M. (2005): Leadership and Innovation Processes – Development of Products and Services based on core competences. In: Journal of Quality Assurance in Hospitality and Tourism, 6(3/4): 31-57.

Peck, J. (2003): Fuzzy Old World: A Response to Markusen. In: Regional Studies, 37(6-7): 729-740.

Pemsel, S. and Widèn, K. (2011): Bridging boundaries between organizations in construction. In: Construction Management and Economics, 29: 495-506.

Pierson, P. (2000): Increasing Returns, Path Dependence, and the Study of Politics. In: American Political Science Review, 94(4): 251-267.

Plum, O. and Hassink, R. (2013): Analysing the knowledge base configuration that drives southwest Saxony's automotive firms. In: European Urban and Regional Studies, 20(2): 206-226.

Polanyi, M. (1967): The tacit dimension. Anchor Books. New York.

Pompl, W. and Buer, Ch. (2006): Notwendigkeit, Probleme und Besonderheiten von Innovationen. In: Pikkemaat, B., Peters, M. and Weiermair, K. (eds.): Innovationen im Tourismus. Wettbewerbsvorteile durch neue Ideen und Angebote. In: Schriften zu Tourismus und Freizeit. Band 6, Erich Schmidt Verlag Berlin: 21-36.

Porter, M. (1998): Clusters and the new economics of competition. In: Harvard Business Review, November-December: 77-90.

Pyo, S. (2005): Knowledge map for tourist destinations – needs and implications. In: Tourism Management 26(4): 583-594.

Rallet, A. and Torre, A. (2005): Proximity and Localization. In: Regional Studies, 39(1): 47-59.

Rammert, W. (2000): National Systems of Innovation, Idea Networks, and Comparative Innovation Biographies. TUTS-WP-5-2000.

Roberts, B. (2002): Biographical Research. Open University Press. Philadelphia.

Rogers, E. M. (1983): Diffusion of Innovation. Free Press. New York

Rose, T.M. and Manley, K. (2012): Adoption of innovative products on Australian road infrastructure projects. In: Construction Management and Economics, 30(4): 277-298.

Rothbauer, P. (2008). Triangulation. In: Given, L. (ed.): The SAGE encyclopedia of qualitative research methods. SAGE, Thousand Oaks: 893-895.

Schmidt, S. (2012): Wissensspillover in der Wissensökonomie. Kanäle, Effekte und räumliche Ausprägungen. LIT-Verlag, Münster.

Schmitz, H. and Strambach, S. (2009): Organisational Decomposition of Innovation and Global Distribution of Innovative Activities: Insights and Research Agenda. In: International Journal of Technological Learning, Innovation and Development, 2(4): 231-249.

Senaratne, S. and Sexton, M. (2011): Managing change in construction projects. A knowledge-based approach. Wiley Blackwell (Innovation in the built environment). Chichester.

Shaw, G. and Williams, A. (2009): Knowledge transfer and management in tourism organisations: An emerging research agenda. In: Tourism Management, 30(3): 325-335.

Simmie, J. (2005): Innovation and Space: A Critical Review of the Literature. In: Regional Studies, 39(6): 789-804.

Smith, K. (2005): Measuring innovation. In: In: Fagerberg, J., Mowery, D. and Nelson, R. (eds.): The Oxford Handbook of Innovation. Oxford University Press. New York. P. 148-179.

Sørensen, F. (2007): The geographies of social networks and innovation in tourism. In: Tourism geographies, 9(1): 22-48.

Stehr, N. (2001): A World made of Knowledge. Society 3-4, 89-91.

Storper, M. (1993): Regional "Worlds of Production": Learning and Innovation in the Technology Districts of France, Italy and the USA. In: Regional Studies, 27(5): 433-55.

Strambach, S. (2008): Knowledge intensive business services as drivers of multi-level knowledge dynamics. In: International journal of services technology and management, 10(2-4): 152-174.

Strambach, S. (2010): Path dependency and path plasticity: the coevolution of institutions and innovation – the German customized business software industry. In: Boschma, R. and Martin, R. (eds.): Handbook of Evolutionary Economic Geography. E. Elgar Publishing, Cheltenham/Northampton: 406-431.

Strambach, S. and Klement, B. (2012): Cumulative and Combinatorial Micro-dynamics of Knowledge: The Role of Space and Place in Knowledge Integration. In: European Planning Studies, 20(11): 1843-1866.

Strambach, S. and Surmeier, A. (2013): Knowledge dynamics in setting sustainable standards in tourism – the case of 'Fair Trade in Tourism South Africa'. In: Current Issues in Tourism: 736-752.

Streeck, W. and Thelen, K. (2005): Beyond continuity. Institutional change in advanced political economies. Oxford University Press. Oxford.

Styhre, A. (2008): The role of social capital in knowledge sharing: the case of a specialist rock construction company. In: Construction Management and Economics, 26: 941-951.

Sydow, J., Lindkvist, L. and DeFillippi, R. (2004): Project-Based Organizations, Embeddedness and Repositories of Knowledge: Editorial. In: Organization Studies, 25 (9): 1475-1489.

Taylor, J.E. and Levitt, R.E. (2005): Inter-organizational Kowledge Flow and Innovation Diffusion in Project-based Industries. Proceedings of the 38th Hawaii International Conference on System Sciences: 1-10.

Ter Wal, A.J. and Boschma, R. (2009): Applying social network analysis in economic geography: framing some key issues. In: Annals of Regional Science, 43: 739-756.

Ter Wal, A.J. (2013): The dynamics of the inventor network in German biotechnology: geographic proximity versus triadic closure. Journal of Economic Geography 2013, *online first*

Thomson, P. and Fox-Kean, M. (2005): Patent Citations and the Geography of Knowledge Spillovers: A Reassessment. In: American Economic Review, 95(1): 450-460.

Tödtling, F., Lengauer, L. and Höglinger, Ch. (2011): Knowledge Sourcing and Innovation in „Thick" and „Thin" Regional Innovation Systems – Comparing ICT Firms in Two Austrian Regions. In: European Planning Studies, 19(7): 1245-1276.

Törnqvist, G. (2004): Creativity in Time and Space. In: Geografiska annaler Series B, HUman Geography 86(4): 227-243.

Torre, A. and Rallet, A. (2005): Proximity and Localization. In: Regional Studies, 39(1): 47-59.

Van De Ven, A., Polley, D.E., Garud, R. and Venkataraman, S. (1999): The Innovation Journey. Oxford University Press.

Vinodrai, T. (2006): Reproducing Toronto's Design Ecology: Career Paths, Intermediaries, and Local Labor Markets. In: Economic Geography, 82(3): 237-263.

Vissers, G. and Dankbaar, B. (2012): Keygene, eine unautorisierte Biographie. In: Butzin, A., Rehfeld, D. and Widmaier, B. (Eds.): Innovationsbiographien. Räumliche und sektorale Dynamik. Nomos Verlag. Baden-Baden.

Wasserman, S. and Faust, K. (1994): Social network analysis. Methods and applications. Cambridge. University Press.

Weidenfeld, A., Williams, A.M. and Butler, R. (2010): Knowledge Transfer and Innovation among Attractions. In: Annals of Tourism Research, 37(3): 604-626.

Wengraf, T. (2001): Qualitative Research Interviewing: Biographic Narratives and Semi-structured Methods. Sage. London.

Yeung, H. (2003): Practicing New Economic Geographies: A Methodological Examination. In: Annals of the Association of American Geographers, 93(2): 442-462.

Anna Butzin
Hacheneyer Str. 174a
44265 Dortmund
Tel.: 0178-1727760
butzin@iat.eu

An den
Vorsitzenden des Promotionsprüfungsausschusses
Prof. Dr. Opp
Fachbereich Geographie
Philipps-Universität Marburg
Deutschhausstr. 10

35032 Marburg

Erklärung

(gemäß § 10, Abs. 1c der Promotionsordnung vom 15.07.2009)

Ich versichere wahrheitsgemäß, dass ich die vorliegende Dissertation selbst und ohne fremde Hilfe verfasst, keine anderen als die in ihr angegebenen Quellen oder Hilfsmittel benutzt sowie vollständig oder sinngemäß übernommenen Zitate als solche gekennzeichnet habe. Die Dissertation wurde in der vorliegenden oder einer ähnlichen Form noch bei keiner anderen in- oder ausländischen Hochschule eingereicht und hat noch keinen sonstigen Prüfungszwecken gedient.

Dortmund, den 11.11.2013

Anna Butzin