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Combining knowledge bases in transnational innovation - microfoundations and the geography of organization

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Simone Strambach

Abstract

The aim of the paper is to contribute both conceptually and empirically to a deeper understanding of the territorial shaping of knowledge combination and its development dynamics underpinning innovation. The importance of combining and integrating knowledge bases from different sources, geographical scales and heterogeneous actors is increasingly recognized in innovation studies. Yet, the question of what limits or enables knowledge combinations in innovation processes and what generates relatedness among unrelated knowledge bases in time and space is not fully answered. Conceptually the paper suggests a more specific focus on microfoundations and temporality by taking into account the economics of organization in more detail. This appears a particularly promising approach, as the causal relations and mechanisms across and between aggregated levels such as firms, sectors, regions, or nations are not well understood.

Empirically the paper explores the micro-dynamics of knowledge combination and its territorial shaping from a transnational perspective. German-Chinese innovation projects in sustainable construction are investigated by using the methodology of innovation biography. This method allows following the time-space path of innovation. It enables capturing knowledge interactions and their unfolding in multi-scalar and cross-sectoral ways.

The results underline a very dynamic geography of organization and barriers for knowledge integration at the micro-level rooted in organizational and institutional path dependencies. The investigation in the interplay between more permanent and temporary organizational forms and its geography holds a large potential for further research to provide new insights into the spatiality of combining knowledge bases in innovation processes.

JEL codes: D83, L14, L20, L84, O31

Keywords: Knowledge dynamics, transnational innovation, microfoundations, economics of organization, innovation biography

1 Introduction

In economic geography and innovation studies the knowledge-centered debate received considerable attention in recent years. Empirical evidence based on different analytical levels challenges established territorial innovation models (TIMs) (MOULAERT and SEKIA, 2003) in several ways. Scholars in innovation research observe that the combination of knowledge from different sources, geographical scales and heterogeneous actors seems to be conducive to innovation and regional development dynamics (ASHEIM *et al.*, 2011a; CREVOISIER and JEANNERAT, 2009; GRILLITSCH and TRIPPL, 2013; HALKIER *et al.*, 2012; MARTIN and MOODYSSON, 2013; STRAMBACH and KLEMENT, 2012). Even in seemingly low-tech sectors, quite complex and multi-scalar networks of knowledge sourcing are often involved in innovation (TÖDTLING *et al.*, 2013).

The scientific debates underline that geographical proximity and co-location as well as dichotomies, such as tacit and codified knowledge or the global-local knowledge interaction, do not provide sufficient explanation for the empirically observed complex, often multi-scalar, and cross-sectoral knowledge processes that obviously seem to characterize innovations. The changing nature of innovation processes and the way in which innovation is organized appears to be a significant feature of the global structural transformation towards knowledge economies (FORAY and LUNDVALL, 1996; ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, 2010).

What remains, however, intensely debated in the literature is what kind of particular combinations matter during the innovation process and for the development dynamics. Dynamics of knowledge – its generation, transformation, interpretation, and use – within and across organizational, sectoral, and institutional contexts are not well understood. At the regional as well as at the sectoral level constraints in knowledge combination and innovative outcomes became obvious. Rather than specialization, the combination of knowledge from different but related sectors and technologies has been identified beneficial for long-term regional growth (Boschma/Frenken 2011). Furthermore the differentiated knowledge bases approach with the distinction of analytic, synthetic and symbolic knowledge bases highlights that these generic types have a crucial influence on knowledge creation and their spatial organization (ASHEIM, 2007).

The importance of combining knowledge is more and more acknowledged; the questions, however, about what limits or enables knowledge combinations in innovation processes and what generates relatedness among unrelated knowledge bases in time and space are not fully

answered. One main reason is that the knowledge-centered debates in economic geography often focus directly or indirectly on particular levels, such as firms, networks, sectors, regions, or nations. How combinatorial knowledge dynamics at the micro-level unfold in time and space in innovation processes, has received little attention so far. Additionally, the way how cumulative institutionally embedded knowledge bases, resulting from path dependent development, are connected and impact knowledge integration remains obscure.

The paper explores the territorial shaping of knowledge dynamics underpinning innovation. It aims to deepen the understanding of knowledge combination and its development dynamics by arguing for a conceptual focus on microfoundations and the economics of organization. It builds on two, mainly unrelated, scientific debates - the neo-institutional approaches of organizational theory and the research on innovation and knowledge dynamics in economic geography. The paper investigates the territorially shaping of knowledge combination and its micro-dynamics from a transnational perspective.

Empirically German-Chinese innovative projects in green building are investigated[1]. The German green building industry is an interesting case study, since Germany is considered as an international lead market in sustainable building. Due to fast urbanization processes and large environmental problems the Chinese market offers a great potential to exploit existing cumulative knowledge bases of German companies in the green building industry for innovative problem solutions.

2 Knowledge dynamics –– microfoundations and the economics of organization

The notion 'knowledge dynamics' has recently been used in the field of research focusing on 'knowledge economics' and applied interdisciplinary by scholars to both the micro- and the macro-level (NERLAND and JENSEN, 2012; TURVANI, 2010; CREVOISIER and JEANNERAT, 2009; HALKIER *et al.*, 2012; STRAMBACH and HALKIER, 2013). Knowledge dynamics is still a fuzzy concept; nevertheless, despite different application levels, the process orientation can be identified as the common key focus. Thereby knowledge dynamics are unfolding from processes of the creation, use, transformation, and diffusion of knowledge. For the development of innovation in products, services, or processes, it is not sufficient to get access to new or complementary knowledge. Rather it is necessary to combine and integrate knowledge bases with the support of intra-and inter-organizational arrangements. Knowledge

[1] Empirical results are based on the international research project ASLINN (Anchorage, Sustainability and Localization of Innovation) focusing on sustainable innovation processes.

production is fundamentally grounded in complex social learning processes which in turn are embedded and shaped by institutional settings. Both knowledge interactions and the value of knowledge are highly context-dependent.

Approaches in economic geography and regional studies have different starting points and perspectives. Thus, there is no comprehensive conceptualization of the ways in which geography influences and in turn is influenced by knowledge interactions. Yet, from scientific debates, two different ways can be identified in which the territorial dimension does play an essential role in knowledge interaction processes: through the mechanism of proximity economics and through the more enduring localized socio-institutional environments built over time in a path dependent way. Therefore the impact of spatiality at the micro-level is not always direct, but often indirect, subtle and varied due to the intersection of spatial proximity with other forms of non-geographical proximities such as cognitive, organizational, technological, social, and institutional proximity (BOSCHMA, 2005; HOWELLS, 2001; TORRE and RALLET, 2005).

Meanwhile, a considerable body of research, investigating the interrelationship and the disentanglement of different forms of proximity and the role of temporary geographical proximity, exists (TORRE, 2008). Differentiated and substantial insights are obtained in both in theoretical and empirical terms which cannot be discussed in detail here.[2] However, besides the methodological and measuring problems and investigations on different aggregation levels, the results clearly underline:
1) there are less simple patterns of proximity-distance ratios in innovation processes than complex webs of overlapping and intersecting non-geographical proximity-distance ratios 2) knowledge combination and space are in a co-evolutionary relationship. The latter is recently acknowledged by scholars proposing a dynamic extension of the proximity framework (BALLAND *et al.*, 2013).

In the paper we argue that the concept of knowledge dynamics provides opportunities to deepen the understanding of knowledge combination and development dynamics. In particular, it achieves to do so through a more specific focus on microfoundations and the distinction of aggregation levels and by taking into account the 'temporality'. Before discussing the rationales behind this argument, it is necessary to introduce the microfoundational perspective.

2.1 Microfoundations

[2] For detailed overviews BALLAND *et al.* (2013)HANSEN (2014); MATTES (2012); TRIPPL and TÖDTLING (2012)

There has been a long-established scientific discussion on microfoundations in social science, which is far beyond the scope of the paper[3]. Nevertheless, since there is little consensus on what microfoundations are, it is necessary to outline the understanding of the notion in this paper. From a methodological point, considering microfoundations means taking into account cross-level effects. In a multilevel perspective, microfoundation denotes taking into consideration lower-level constituent units when explaining higher levels of analysis. It argues for a systematically look at the origin and nature of the macro phenomenon which are often explained by taking recourse to theoretical concepts related on the individual and individual actions. This is the case for example with the individual-level concept of 'cognition,' which has its origin in cognitive science and is applied to levels such as industries and sectors. However, this is not considered to be microfoundational, as there are uncertainties about whether the concept and its mechanism need to change when applied across levels and contexts. Without developing on what is named a 'meta-theory' (BARNEY and FELIN, 2013) or 'aggregation theory' (DEVINNEY, 2013) or the 'logic of aggregation' (Coleman 1990), which built bridges across the level of analysis, the assumed direct causality can be questioned. In other words microfoundation does not imply reducing research issues solely to individuals; the latter is, as BARNEY/FELIN (2013) put it, 'micro' but not 'microfoundational'.

Why is such a perspective useful for exploring the spatiality of combinatorial knowledge dynamics underpinning innovation?

In a strict sense, knowledge can only be created and used by individuals. Without them organizations like firms are not able to produce knowledge (GRANT, 1996; NONAKA and TAKEUCHI, 1995; POLANYI, 1966). As NOOTEBOOM (2010) points out, cognition as a mental activity by definition cannot be applied to aggregates such as organizations**.** The fact that individuals possess knowledge has far-reaching implications. It speaks in favor of the integration of organizational theories in meta-theory building by exploring the territorial shaping of knowledge combination. The question how to integrate knowledge bases and skills to foster and exploit 'collective' knowledge has become a building block of many knowledge-based studies on organization focusing on changes in architectures of firms and industries. Consequently, for answering the questions about what limits or enables knowledge combinations in innovation processes and what generates relatedness between unrelated knowledge bases, economics of organization, the institutional arrangements as well as the

[3] For a deeper discussion in social science and organizational studies see for example Coleman 1990, Elster 1989, in organizational studies Devinney 2013, Barney and Felin 2013, Eisenhardt et.al. 2010, Felin and Foss 2011, Hodgson 2012, Winter 2013.

time dimension play an important role. When moving from the individual to the firm and industry level, institutional settings are playing a major role, because they impact actions and knowledge formation due to their constraining and enabling function.

2.2 Time, institutions and scales – the interplay between permanent and temporary organization

The fundamental problem of the economic organization – how to make the large body of very important, but unorganized and 'dispersed' knowledge widely available – have been acknowledged for a long time. Already HAYEK (1945, PP. 520–522) denoted that knowledge of the relevant facts is in many cases initially dispersed among various people due to its generation in the particular circumstances of time and place. He puts emphasis on the question of appropriate institution building as one of the main problems of designing efficient economic systems. Later on COASE (COASE, 1937) and WILLIAMSON (1987) stressed the central role of organization and pointed out the limitations and possibilities of learning associated with different forms of economic organization. Grounded in the resource-based and developed further in the evolutionary theory of the firm (PENROSE 1959, (NELSON and WINTER, 1982), knowledge and human resources have become the pivot of the organization. Firms vary in their ability to acquire and exploit knowledge. Organizational routines as institutional arrangements are generally considered to be driving this heterogeneity. Due to their stabilization function, routines lead to knowledge accumulation based on localized learning in spatial environments. In organizational studies, routines are located at the macro-level as key elements responsible for cumulative knowledge dynamics, firm-specific capability building, and organizational path dependence over time.

In evolutionary economic geography (EEG) organizational routines represent the micro level and are important elements used to explain continuity and change of paths related to entities at the meso level such as industries and regions. By determining the mechanisms of related variety and regional branching – understood as the way in which new routines develop out of technologically related routines – they contribute to regional economic adaptability (BOSCHMA and FRENKEN, 2011). Cognitive proximity is an important explanation for the relatedness concept. The latter is defining regional potentials to make connections and re-combinations between local (and non-local) complementary pieces of knowledge that have some degree of cognitive proximity. However, organizational routines themselves are largely treated as 'black-boxes' in EEG. By taking recourse to the theoretical concept of cognitive proximity related to the individual and the individual's actions, organizational change and the

micro-dynamics underlying intra-and inter-organizational arrangements, which lead to observed structures of regional or the sectoral level, may remain underestimated.

In the recent approach of the evolutionary firm theory, the knowledge-based view takes center stage of these micro dynamics. Central features are the set-up of relatedness in knowledge formation and knowledge integration as well as the transformation of cumulative individual knowledge bases into collective knowledge at the system level. Since the capabilities to not only utilize, but to also create new knowledge are considered the most important source of firms' sustainable competitive advantage, the concept focuses on firm contexts that are viewed as communities capable of generating stable cognitive models over time and continuously fostering and exploiting collective knowledge (NONAKA *et al.*, 2000; TURVANI, 2010; GRANT, 1996). Cognitive models are not static, instead cognitive capabilities are changing dynamically in interactions and learning processes with the social environment. In labor division of knowledge production, the approach has a strong organizational focus on the cognitive coordination (NOOTEBOOM, 2010).

Emphasize is placed on the creation of rules, routines, and the elaboration of meaning, which provide cognitive orientation and foster common cognitive frames as well as interpretative patterns. It is argued that these are the dynamics giving rise to shared forms of action, learning, and knowledge formation in a social environment and in problem-solving activities. Over time cumulative knowledge dynamics lead to shared knowledge held by the members of the organization intersecting between sets of individual knowledge bases. Relatedness at the micro-level is connected to shared knowledge, which enables a group of individuals to coordinate their activities without centralized decision-making or explicit mutual communication (HECKER, 2012; TURVANI, 2010).

The efficiency of knowledge integration is influenced by the level of shared knowledge, the frequency and variability of the activity, as well as the structure, which economizes communication (GRANT, 1996; KOGUT and ZANDER, 1992). The wider the span of knowledge to be integrated, the more complex is the creation and management of organizational routines and capabilities (NONAKA and TAKEUCHI, 1995; GRANT, 1996). The production of new knowledge is facilitated when it depends or builds directly on previously generated cumulative knowledge bases structured over time by co-evolved institutional settings. Permanent organization in the form of rules and processes create relatedness due to shared norms and values which in turn facilitate mutual understanding, learning and the generation of new knowledge (EKSTEDT *et al.*, 1999). At the same time permanent organizational forms

lead to a trade-off between knowledge exploration and knowledge exploitation at the level of the organization (MARCH, 1991). Cumulative knowledge dynamics tend to substitute knowledge exploration through more incremental knowledge exploitation.

Consequently, not all combinations of knowledge sets are the same. Knowledge combinations with a transversal nature characterized by the integration of originally separated knowledge bases located in distinct (non)-technological, sectoral and regional institutional settings spread over a heterogeneous actors imply greater challenges. Innovations based combinatorial knowledge dynamics of a transversal nature are often connected with temporary organizational forms. Exploring the questions what hinders and enables knowledge combination and what creates relatedness between unrelated knowledge bases, the interplay between more permanent and temporary organization forms is an important issue.

Linking knowledge practices at the micro-level in innovation to aggregated macro-level structures may provide more detailed insights into knowledge combination and their territorial shaping. Investigating the territorial shaping of combinatorial knowledge dynamics requires an integrated view in order to grasp trajectories of knowledge as a result of simultaneous and interacting dynamics at the micro- and macro-level. The geography of organization as well as the impact of space and place remain underexplored in organizational theories. The same holds true for the distinction between the three epistemologically different types knowledge bases (ASHEIM *et al.*, 2011b; ASHEIM and GERTLER, 2005). Applied at the industry level it is underlining that these generic types impact the geography of organization. In some industries, as for instance the pharmaceutical or the automotive industry, knowledge exploration and exploitation processes have been separated in time and space for a long time. In other sector contexts with a dominant symbolic knowledge base, these processes are more tightly coupled in time and space though. On the basis of the synthetic, analytic, and symbolic typology of knowledge bases the understanding of marked sector differences in the geography of organization in innovation has made substantial progress (ASHEIM and COENEN, 2006; COENEN *et al.*, 2005)

How combinatorial knowledge processes are temporarily organized and become institutionalized over time, and how more permanent institutional structures located at different aggregated social or spatial levels affect knowledge combination will be explored in the empirical case study in sustainable construction.

3 Empirical methods and research design

On the one hand, the central points of interest in the study were the territorial shaping of knowledge combination and their temporary organizational arrangements. In innovative projects a set of organizational actors are working together on a complex task over a limited period of time. Compared to more routine projects, they are risky and characterized by high uncertainty related to the unknown outcome. By investigating the innovative project itself as the unit of analysis, the aim was to gain a deeper understanding of the spatial and organizational division of labor underpinning complex knowledge combination and integration processes.

We examine how multiple organizational actors coordinate their collaborative knowledge activities and mutual adjustments in innovative sustainable projects with a limited duration. The study aimed to explore how the enduring intersecting national and sectoral institutional arrangements at the macro-level, in which actors are embedded, impact their knowledge practices. Under a transnational perspective the taxonomy of knowledge base is especially interesting. Since symbolic knowledge is outlined as highly contextual and sensitive to distance, it bears extra challenges for transnational learning processes in knowledge combination (ASHEIM, 2007). A special focus is placed on how symbolic knowledge on lifestyles, cultural conventions, norms, and values of the receiving context is sourced and combined with cumulative synthetic knowledge bases for the creation of innovative solutions in green construction.

A qualitative research design with a mixed method approach was applied, including document and media analysis, literature review, and explorative as well as semi-structured interviews. To explore the nature of knowledge dynamics in innovative projects, the research procedure of innovation biographies was applied in the fieldwork (BUTZIN, 2012). A combination of different types of qualitative interviews was used, connected with a snowball sampling strategy to investigate an innovative project's entire life span. One of the main advantages of such an approach is to grasp the dynamism without being limited to certain predefined geographical or sectoral scales or firm boundaries. Knowledge interactions, the sequences, the actors' constellations, their relationships, their knowledge contribution, and their institutional as well as geographical settings can be mapped. In order to reconstruct hidden knowledge trajectories underpinning innovative projects, qualitative egocentric network analysis, knowledge content mapping, and comparative institutional analysis were used. The empirical data were complemented by researching and providing contextual-material that makes further sense of the particularities of each case. The obtained interview material and the secondary data are then confronted and synthesized in the case reconstruction.

Knowledge-intensive business services (KIBS) were at the centre of the study in sustainable construction. Substantial theoretical and empirical research in KIBS identified these firms as drivers of knowledge dynamics in multi-level contexts (STRAMBACH, 2008). In European countries the majority of KIBS are small- to medium-sized firms that act primarily in regional and national contexts. However, as internationalization is becoming more important, the transfer of local knowledge to other regional and national contexts is being promoted by KIBS (ROBERTS, 2000). KIBS operate in all knowledge phases along the generic knowledge value chain from exploration and examination to exploitation. In sustainable construction primarily the sub-sector of the so-called technology-based KIBS (t-KIBS) is present, that is for instance technical engineering and architectural t-KIBS, focus is put mainly on synthetic knowledge.

The empirical results are based on the in-depth interviews of t-KIBS firms conducted in Germany and in China. The criteria for the firm selection were differences in size and modes of internationalization. Software for qualitative data analysis was used (MAXQDA) and the data analysis followed the methodological approach of the qualitative content analysis according to the developed steps of MAYRING (2000). The material was examined mainly by theory-led coding and supplemented by inductive ones formulated directly out of the material. This kind of proceeding increased the openness and flexibility in order to grasp and discover new aspects, which so far had not been considered theoretically.

4 Sustainable construction in Germany and China – distinct development paths and institutional settings

The path dependent developments of the green building industry within the German and Chinese national economic systems is briefly outlined with the aim to provide an insight into the more enduring institutional environments in which firms are operating. It is assumed that the intersecting national and sectoral institutional arrangements, which are built over time, have an impact on the knowledge practices of firms involved in temporary innovative green building projects at the micro-level.

4.1 Intersecting national and sectoral institutional settings in Germany

Germany has several decades of experience in green building. Compared to China, the evolved paths of the green building industry and the co-evolving institutionalization processes are well advanced. Sustainable construction – often referred to as green building or green construction – is a subsector of the ‘green-tech sector’. The latter emerged as a cross-sectoral industry with its origin in the late 1970s. An early regulatory push on national level promoted a growing ‘green-tech sector.’ The accelerating shortage of resources as well as growing

environmental problems have led to strict environmental regulations and laws. With the help of incentive systems, designed for actors in research areas as well as for the demand side, the development of innovative eco-efficient technologies and sustainable solutions was pushed forward over time (RENNINGS *et al.*, 2008); (BUNDESMINISTERIUM FÜR UMWELT, 2009). In 2002 Germany adopted a nationwide sustainability strategy to promote socio-ecological transformations. Green construction is one of its key areas. Sustainable construction is centered on efficiency enhancements in energy and water consumption through optimized design and the usage of sustainable materials. The main focus is to (re)construct or run buildings in a way that they are economically, ecologically, socially and in terms of urban planning sustainable (DEUTSCHE GESELLSCHAFT FÜR NACHHALTIGES BAUEN, 2009; BUNDESMINISTERIUM FÜR VERKEHR, BAU UND STADTENTWICKLUNG, 2010).

The construction industry is a project-based industry, where a temporary organization is a dominant sector-specific feature (GRABHER, 2004; EKSTEDT *et al.*, 1999). The context of knowledge production in construction is described by a high degree of complexity, local boundedness, loose coupling, and a strong institutionalization due to the project-based nature. Uniqueness originates in the place-specifics of the site, different building owners, the environment, or the legal frame. Plus, it requires tailor-made solutions (BUTZIN and REHFELD, 2013). In Germany formal and informal institutionalization in construction is pronounced at the national level. Stability in the complex project-based construction industry is provided by established institutional arrangements. Action and knowledge formation are guided by technical and labor market regulations and the set-up of sectoral governance structures that are characterized through an inter-organizational division of labor along the value chain with predefined roles for actors. However, sustainability issues bring along additional challenges as they mostly require the integration of highly specialized synthetic knowledge bases located in other sectors, which are often not directly related to the construction industry. Sustainable construction projects are complex and described as multidimensional tasks (HEGNER, 2009). They are a result of integrated solutions from planning, design, and construction all the way to operations and maintenance. All of these aspects have to be taken into account right from the beginning. The required early and holistic planning causes a strong need to change the sector-specific industrial practices connected with the established institutional arrangements.

The development path of the green construction industry in Germany is closely connected to institutional changes of the sector-specific organizational arrangements. Actors in Germany use the established institutional forms – namely the association building, which is characteristic for the national innovation system – and adopt these to the requirements of the

new sector. In 2007 the German Sustainable Building Council (DGNB) was founded by forty organizations of the construction as well as property industry and thus allowed actors to reach a critical size to initiate institutional change.

The DGNB is the central organization for the exchange of knowledge and the bundling of various actors' competencies across the entire value chain of the construction and property industry. Members are architects, engineers, construction firms, building contractors, construction product manufacturers, investors, builders, owners, project managers, operators, supply and disposal companies, members of the public sector and NGOs, as well as representatives from academia and testing laboratories. The council is a key driver of institutional change and has been taking a leading role in combinatorial knowledge dynamics directed towards a common understanding of the meanings of appropriate sustainable construction practices. It is beyond the scope of this section to analyze institutional change in detail. However, the council participated to a great extent in the development and implementation of new institutions in the form of a new and meanwhile widely recognized voluntary standard – the German quality label for sustainable building: *Deutsches Gütesiegel für Nachhaltiges Bauen*. This standard entails a certification system that assesses not only ecological aspects, but also the economic performance of buildings as well as their socio-cultural and functional quality by utilizing transparent indicators as well as measurement and assessment systems. Additionally, the process quality is assessed based on holistic, integrated planning processes, which consider a property's complete life cycle, including its operation, utilization, and maintenance as well as deconstruction (DEUTSCHE GESELLSCHAFT FÜR NACHHALTIGES BAUEN, 2009).

Compared to China, the evolved paths of the green building industry and co-evolving institutionalization processes in Germany are well advanced. Sustainable building guidelines were established on national level and are to be adhered to whenever new public buildings are constructed (BMVBS 2011). A so-called energy pass is obligatory for all new buildings and for ones that undergo major renovations. Sustainability in construction is no longer a question of whether to put it on disposition or not, but much more of the right strategies and ways to implement it.

Even though the conventional construction industry in Germany is assessed with a low-level international competitiveness (BUTZIN and REHFELD, 2013; NORDHAUSE-JANZ *et al.*, 2011), for sustainable construction the opposite is the case. The early implementation of environmental guidelines, the resulting innovation pressure combined with incentive systems,

as well as a sophisticated, environmentally-aware demand side for energetic optimization of commercial and residential buildings have led to Germany's development towards an international lead market in sustainable building. Through the wide application of innovative, eco-efficient technologies, highly specialized accumulated synthetic knowledge bases and benefits of scale effects have developed. These obtained comparative competitive advantages for German companies in the world market. Thus, the Chinese market offers a great potential to harness existing cumulative knowledge bases of German companies for sustainable problem solutions.

4.2 Intersecting national and sectoral institutional settings in China

Not only in China but worldwide the building sector is responsible for a large portion of the primary energy consumption and contributes immensely to the climate-relevant carbon emissions. The fast urbanization processes with an increasing demand for living space push a persistent construction boom in the urban centers and contribute to the further aggravation of ecological problems. The share of China's construction sector in the country's total energy consumption is currently estimated at 33 % (CHINA GREENTECH INITIATIVE, 2013). Hence it holds an enormous potential for the reduction of energy intensity – a central environmental target of the government's current five-year plan. The issue of sustainability just recently started to emerge. With the 11th five-year plan in 2006, China puts sustainability on the national agenda (SADELER, 2011). The current 12th five-year plan entails quantitative objectives for the first time. Even though sustainability regulations were just introduced and might be difficult to enforce, they seem to show a dynamic development.

Compared to Germany, China's development path in sustainable construction is just at its beginning stages. The institutional framework conditions of the Chinese construction sector in general and green construction in particular differ significantly of those in Germany. By now ambitioned national objectives have been determined in China and supportive legal regulations have entered into force. Until 2015 one billion cubic meters of green building floor space is supposed to arise. Today sustainability concerns are anchored firmly as a part of the national institutional framework conditions. However, the implementation of the national environmental guidelines on regional and local level in the Chinese multi-level system seems to be the greatest challenge (HEILMANN, 2004; ABELE, 2009). Meager commitments on local and municipal level as well as inefficient control systems in conjunction with improper financial incentive systems prove to be hindering factors in the implementation process. Various studies find that national environmental guidelines are routinely violated and subverted.

China's building industry is very dynamic and characterized by its extremely short building life cycles in comparison to other industrial nations (RICHERZHAGEN *et al.*, 2008). The established sectoral institutions of the building sector are hardly conducive to unfold the potentials of sustainable construction. Due to the just now establishing sector, major weak points are the missing expertise in sustainable design and eco-efficient technologies as well as insufficient indicators and monitoring/audit systems for the optimization of eco-efficient buildings (ABELE, 2009; CHINA GREENTECH INITIATIVE, 2013). Particularly, the sector-specific organization of the value chain seems to hinder the unfolding of sustainable construction.

The current consumer demand for sustainable construction is also at a comparatively early stage. Though, due to serious environmental pollution, the awareness of environmental protection is growing in at least some parts of the Chinese society. Through added market demand, this development may facilitate the dynamics of the development path for sustainable building.

5 Micro-dynamics of knowledge in Chinese-German innovative projects in sustainable construction – empirical insights in the geography of organization

For German engineering, architecture, planning, and development firms the Chinese market is especially attractive. Given the dynamic economic development, the fast urbanization together with the growing awareness for sustainability, the Chinese target market offers a high potential for sustainable building projects. Furthermore, German firms enjoy a sound international reputation in China due to their long-standing experience (ABELE, 2009).

Despite these described favorable conditions, numerous examples have shown that an innovative sustainable solution – such as the passive house developed in Germany – does not inevitably bring a sustainable impact when climatic, cultural, and institutional differences are ignored during the transfer to other countries. For a sustainable outcome, transfer processes require all-encompassing adaptations as well as an intelligent and locally sensitive planning and implementation process. An example is Anting, a suburb of Shanghai, which was planned and built by German firms in the Bauhaus design and equipped with modern eco-efficient technologies. Yet it still remains vacant in large parts (SCHLESINGER, 2006; YANG, 2011). There, the passive house started to mold, either due to different climatic conditions or improper handling. Moreover, prospect tenants for the energy-efficient apartments could not be found, because their windows face east- or westward, and thus ignore the fact that Chinese prefer apartments with a North/South orientation based on the better Feng-Shui.

These examples show that cumulative knowledge bases cannot be easily transferred to or used in different socio-economic contexts with distinct institutional framework conditions. The localization of innovative green construction projects seems to be crucial for the acceptance and further diffusion. It generates the need for complex knowledge combinations of ecological, economical, social, functional, and technical aspects in the adaptation to institutional place-specific conditions. In order to meet the intended targets, the combination and integration of symbolic knowledge of the receiving context, to where the cumulative knowledge is transferred, seems to be an important precondition. That is especially the case when not only economic and technological objectives are pursued, but also knowledge as well as technology transfer is to contribute to a sustainable development in target countries. The less successful projects prove that particularly the place-specific embeddedness holds great challenges for the companies in the German-Chinese collaboration.

On the basis of innovation biographies of innovative projects in sustainable construction, the empirical study investigates the connection of the spatial and organizational division of labor. In the centre remains the question how the more enduring socio-institutional environment, in which firms are embedded, impact their knowledge practices in transnational innovation projects.

5.1 Knowledge combination in transnational innovative projects between temporary and permanent organizing

The study shows the complex geography of organization in knowledge combination underpinning innovative projects in sustainable construction. Generally, a project can be defined as a sequence of events. Its dynamics depend on certain qualities of temporality (that are embedded in the process itself) and the characteristics of the relationship, such as the frequency, duration, and density of interaction between and among organizations (BAKKER, 2010; GRABHER, 2004; JONES and LICHTENSTEIN, 2008). Based on the empirical results, figure 1 illustrates a generic value chain of the construction projects' development process and the organization of knowledge interactions in Chinese-German collaboration.

The intensity of knowledge activities in the first design and planning phases, characterized by a high degree of new knowledge creation, are mainly located in Germany and undertaken by German KIBS in inter-organizational collaborations. Different t-KIBS such as architects, landscape architects, and engineering KIBS with highly specialized synthetic knowledge bases in different technological realms (for example intelligent energy-efficient building

technology, sustainable material, or water treatment methods) contributed to the projects with highly specialized knowledge components.

For the mainly small sized t-KIBS operating in international space, the capability to mobilize network relationships and to set-up connections with collaboration partners, who can provide the necessary specialized knowledge inputs for the creation of innovative problem solutions in sustainable construction projects, appears to be decisive. The empirical results underline that the inter-organizational arrangements of the German t-KIBS, which were established for innovative projects, connect mostly spatially dispersed organizational actors and span over several urban agglomeration areas.

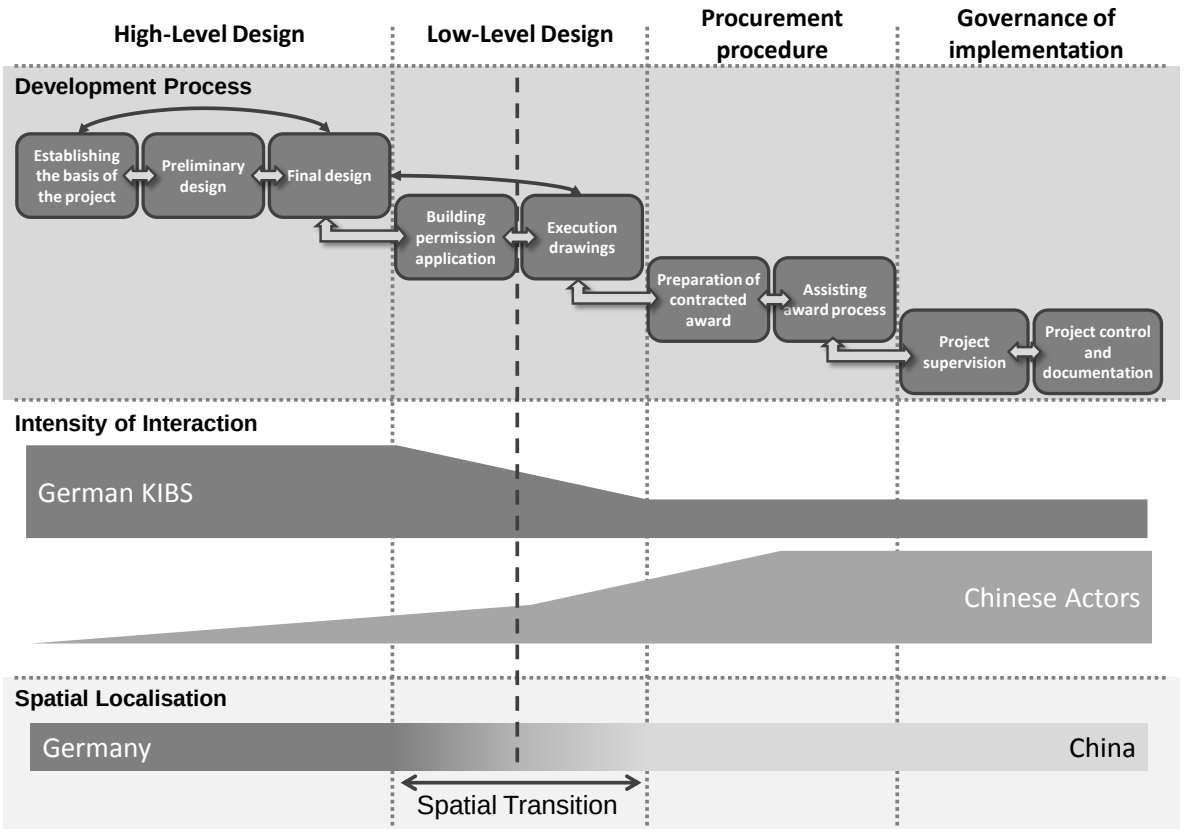

Figure 1: Organization of knowledge interactions in the development process of construction projects in Chinese-German collaboration

After completion of the design and planning phase, the leadership of the projects shifted to the Chinese side and so did the predominant location of the knowledge interaction processes. This change is typical for transnational construction projects in China, due to the specifics of the institutional rules and the Chinese linear organization of the construction value chain. The German t-KIBS that originally designed and planned the project are usually no longer involved in the further project development stages. State-owned local design institutes (LDIs) in the possession of the official licences for approval planning (that foreign t-KIBS usually

lack) take over the legal responsibility. Often a shift to Chinese actors can already be observed in the execution planning stage, but usually the shift occurs in the procurement procedure. The construction management, the project supervision, and the overall governance are undertaken by Chinese actors.

The empirical results point out that these distinct differences in the institutional setting and the Chinese organization of the construction value chain are potential sources for tensions, conflicts and difficulties in the localization process of innovative green construction projects. After finalizing the high-level design and planning, two things have been observed. First local design institutes tend to modify sustainable concepts. Second Chinese actors further down the value chain are mostly not willing to pay for the construction supervision and consultation of German t-KIBS. Furthermore, the Chinese general contractors or construction management firms are often resistant against such supervisions. The consequences of this kind of value chain organization are often quality losses for the originally designed project in the realization phase. In many cases, Chinese actors replaced the planned sustainable material by cheaper material at the expense of sustainable aspects. Misinterpretations of the construction and planning schemes took also place in the course of the implementation phase.

In a more indirect way the embeddedness of the involved actors in their more enduring socio-institutional environments impact knowledge practices and action logics (TOLBERT and ZUCKER, 1996). Already in project design and planning phases cognitive distance, different perceptions and interpretation patterns between actors in the transnational knowledge production, often lead to value tensions regarding the need and evaluation of sustainable aspects. The involved heterogeneous Chinese actor groups had to be convinced of the benefits diverse sustainable solutions have when considering a long-term view. To invest extra costs for sustainable artifacts and the worries about the functionality in a Chinese setting were two of the most important cruxes. What became clearly obvious in the empirical results was that the more permanent institutional contexts, in which actors are embedded, foster different action logics and thus impact knowledge formation and integration differently. In the perception of the German t-KIBS operating in green construction, sustainability did not emerge only in coupling together environmental friendly technologies, but is much more the outcome of the complete system design and development. Each project in green construction is unique and has a certain degree of novelty. German actors expressed that they are already happy when 60 or 70 percent of the original system will be realized in the end.

In projects evaluated equally successful by the German and the Chinese actors, we found that the German t-KIBS adapt their knowledge practices at the different sector specific institutional context. Central German actors, who were aware of the tensions caused by the Chinese sectoral institutional settings, worked voluntarily (free of charge) in the execution and implementation phase in certain projects. Mainly value-driven they provided experienced-based cumulative knowledge in consulting the governance of such complex projects without payment.

Moreover, we found changes in knowledge practices on the side of Chinese actors resulting in the appreciation and integration of knowledge inputs of their German collaborators in the governance of the innovative projects. Chinese actors found ways to convince other actors to include payment for the travel and staying costs of the German collaborators. Changes in perceptions and cognitive framing among the heterogeneous involved actors seem to be influenced essentially by modes of temporary organization of the knowledge practices in these innovative projects. In the following section we use the empirical case of the Chensan Botanical Garden in Shanghai to illustrate this in more detail.

5.2 Modes of temporary organization - embededdness and dynamic proximity

The innovative project in sustainable construction comprises the planning and realization of the Chenshan Botanical Garden in Shanghai, connected to the Expo 2010. With 200 hectares, it was a very large project, especially compared to European dimensions. For instance, the Botanical Garden in Munich that was created in 1919 only spans over 20 hectares. Additionally, it was a very complex project since the garden not only consists of green space, expanses of water, but also of several buildings. Besides the main entrance building, restaurants, and glasshouses, a large research building was implemented. After the architectural competition in 2005, the project started with a relatively short realization phase. The opening of the Botanical Garden was connected to the Expo in 2010 and the entire completion was achieved at the beginning of 2011.

The focal firm of the innovation is a small-sized landscape architecture company with four employees located in Munich. This t-KIBS won the competition together with its larger collaboration partner, an architectural t-KIBS. For the Botanical Garden, principles of traditional Chinese horticulture were combined with the use of modern sustainable technologies. This was one of the main reasons why this small t-KIBS was successful in the competition. Since 2001, the owner, who is also lecturing urban and landscape planning at the University of Munich, travelled to China several times to study Chinese horticulture and

urban planning. One of his Chinese students, who later became employed with him, organized several meetings at universities and with people from the public administration to discuss Chinese and European urban planning. This cumulative symbolic knowledge on Chinese aesthetics and traditions enabled the small t-KIBS to create the specific conceptual approach of the Garden: the specific mixture of Chinese and European aesthetics linked with environmental friendly technologies. The involved German and Chinese actors consider the Chenshan Botanical Garden as a very successful project, even though not all initially envisioned innovative and sustainable solutions could be realized.

Figures 2 & 3 map the involved types of actors, their locations, the main knowledge inputs, as well as modes of temporary organization in knowledge interaction processes, as they appeared a posteriori, reconstructed from the empirical material of the innovation biography. The innovation process shows a complex constellation of heterogeneous spatially dispersed organizational actors.

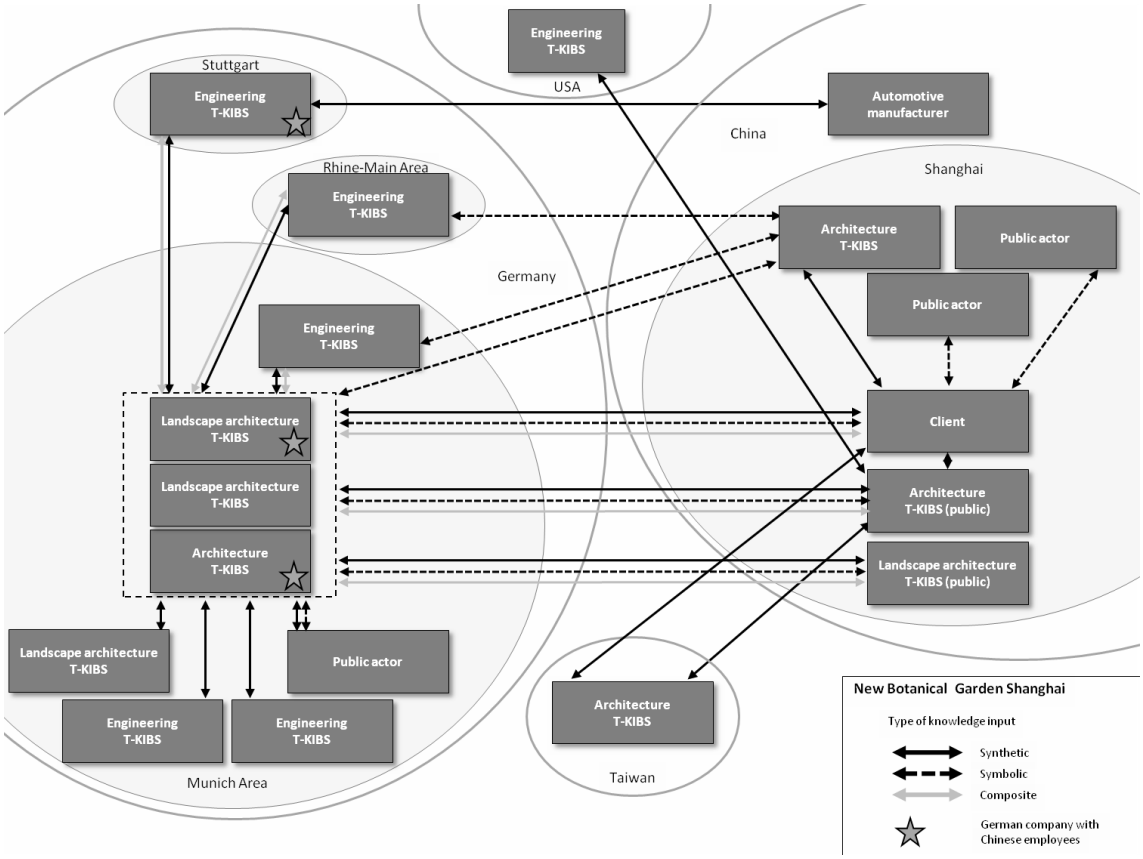

Figure 2: Involved types of actors, their location and knowledge input in the innovative project

On the German side, different t-KIBS, such as architects, landscape architects, and engineering KIBS, as well as public actors, contributed with highly specialized synthetic and symbolic knowledge components to the project. The involved German t-KIBS, spatially

located in different agglomeration areas, were specialized in synthetic knowledge within various technological realms, such as intelligent, energy efficient building technology, water treatment methods, glasshouses and bridge construction, or botanical/landscape planning. None of them had a subsidiary in China, but two held established network relationships to a German t-KIBS in Shanghai. On the Chinese side a similar actor constellation was found, comprising the client, several state-owned t-KIBS, as well as different public actors all situated in Shanghai. Additionally, in the implementation phase international actors located in the US and Taiwan provided synthetic knowledge inputs for the project (figure 2).

The figures give only a static picture and reflect the dynamics in knowledge combination and their territorial shaping only to a minor degree. The knowledge production is characterized by a complex labor division, changing actor constellations as well as shifting geographical locations, often chosen situational in order to provide temporary geographical co-presence.

The meaning of sustainability is not fixed and highly context-dependent. The findings provide substantial empirical evidence that the localization of innovative sustainable construction projects in the Chinese market generate the need to combine highly specialized synthetic knowledge bases from several technological domains with symbolic knowledge of the receiving context. Based on the empirical inter-organizational arrangements on the German side, China-specific symbolic knowledge was sourced and integrated in different ways. In the labor division of the knowledge production, German t-KIBS were involved with China-specific symbolic knowledge, integrated in their own permanent internal organization, either in the form of Chinese employees or German employees with work experiences in China (figure 2). As in this case study, we found that focal firms, responsible for the coordination and governance of knowledge activities in complex sustainable construction projects, could usually rely on internal China-specific symbolic knowledge bases in their permanent organization. Chinese employees within German t-KIBS or German employees with Chinese experiences obviously took over pronounced boundary-spanning roles. Their expertise in the synthetic knowledge fields and their institutional embeddedness in both national contexts enable them to bridge cognitive distances, translate different meanings, and contribute to a common understanding among the involved heterogeneous actors during the knowledge combination processes.

Opening up space in the form of temporary co-presence with different durations turned out to be an important coordination mechanism used in the inter-organizational arrangements of knowledge combination. The central German project team consisted of three independent t-

KIBS firms: the small landscape architecture firm, the Munich subsidiary of the collaborating architecture firm from Stuttgart, and another small-sized landscape architecture firm. Right from the beginning the three focal actors decided to share a joint office in Munich for the duration of the project. Even though all three members of the core team were placed in Munich, geographical proximity in the form of working on site in Munich was perceived as necessary despite the extra costs. The knowledge production process was subject to both uncertainty and unforeseen situations, whereas the time frame was very tight in German terms. By working on site with the central team, temporary stability in the form of co-location opened up space for the spontaneous, ad hoc interaction and continuous knowledge exchange. The core team was facing the task to absorb the different specialized expertise of the collaboration partners and to transmit the necessary symbolic knowledge to them about cultural and aesthetic visions in order to meet the Chinese client side. By doing so, the project leaders had to enable the independent t-KIBS to address these needs in the course of developing the knowledge components for which they were responsible. To ensure the matching and the integration of the knowledge components during the design and planning phase, several temporary meetings in co-presence, lasting one or two days among the involved German t-KIBS, were required. Geographical co-presence facilitated the development of a common meaning and understanding of the specifications of the various knowledge modules regarding their material and intangible characteristics.

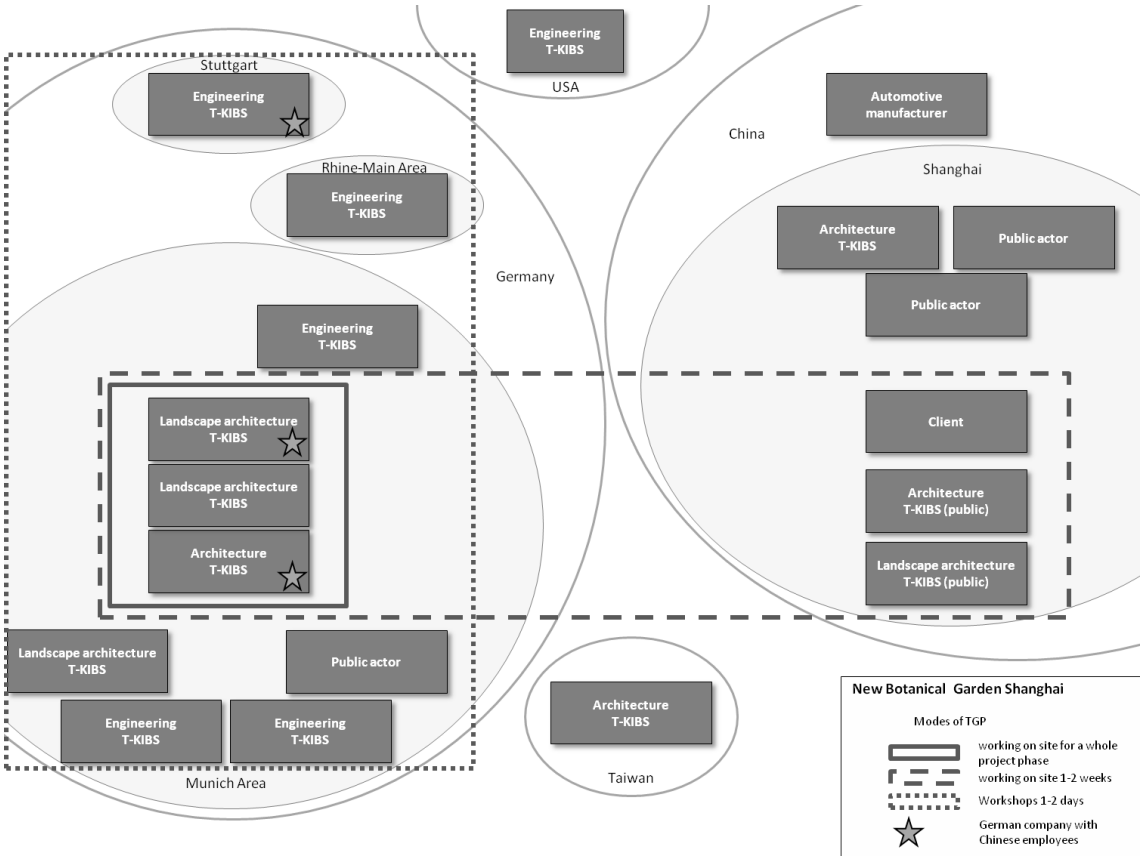

Figure 3: Modes of temporary co-presence between different actors in the knowledge interaction processes

By contrast, the longer duration of one or two weeks of geographical co-presence as coordination mechanism was only used between the core team and Chinese actors. In addition to multiple short-term visits and meetings located in Shanghai, longer time periods working together on site at the office in Munich were necessary in order to exchange and absorb synthetic object-related knowledge and cultural-based symbolic knowledge. Overcoming cognitive distance-based socio-cultural dissimilarity and developing a common understanding and shared knowledge among both the key German and Chinese actors seems to require a longer time period of face-to-face interactions. Moreover this mode of temporary organization changed proximity relations by facilitating learning and reducing social distance and by contributing to changing practices of the German and Chinese actors. Due to the established social relationships and a common knowledge base in the former design and planning phase, the knowledge inputs of the German t-KIBS was very welcome and Chinese actors paid at least the travel cost. Members of the German core team for example travelled more than fifteen times to the construction site in Shanghai for supervision and consulting of the local actors during the realization phase.

6 Summary and Conclusion

In the global structural transformation, knowledge and innovation processes have become increasingly complex. In recent years innovation research has acknowledged a qualitative shift towards more complex and distributed knowledge interaction processes in both organizational and spatial terms. Yet, the question of what limits or enables knowledge combinations in innovation processes and what generates relatedness among unrelated knowledge bases in time and space are fairly unclear. From a micro-level perspective the empirical study in sustainable construction explored how combinatorial knowledge processes are temporarily organized and territorially shaped.

In EEG there is increasing awareness that institutional change is required to enable the emergence of new industries (BOSCHMA and FRENKEN, 2009). The analysis of the distinct development paths of the German and Chinese green building industry and the different temporality of the co-evolving institutionalization processes provide empirical evidence for this argument. Furthermore, the results underline that more permanent intersecting institutional settings located at the national and sectoral level, in which the actors are embedded, affect combinatorial knowledge creation. Key drivers of institutional trajectories are regulative, normative, and cognitive forces (SCOTT, 2001; TOLBERT and ZUCKER, 1996). The trajectories of the institutions are aligned and supported in varying degrees by these forces. While in China regulative forces in green building have been put in place in recent years, the alignment of normative and cognitive forces of the institutional trajectory does not seem as advanced as in Germany, where the co-evolving institutionalization processes in sustainable construction unfold over several decades. The results demonstrate that the embeddedness of the actors in the more enduring institutional setting influence knowledge practices and foster different action logics at the micro-level, leading to barriers and tensions in knowledge combination.

The cumulative knowledge in multiple eco-efficient technologies and a sound international reputation in sustainable solutions are strategic advantages of German companies in emerging global markets. Nevertheless, the study shows that cumulative knowledge bases cannot easily be transferred or used in different socio-economic selection contexts with distinct institutional framework conditions. The value of knowledge resources depends on environments in which they are put to use. Particularly innovation processes with a sustainable character generate the need for complex knowledge combinations of ecological, economical, social, functional, and technical aspects in the adaptation of institutional place-specific conditions.

Successful innovative projects in sustainable construction underline the need for actors adapting the knowledge practices in the localization process. The integration of symbolic knowledge bases of the receiving context seems crucial, as the meaning of sustainability is not fixed. As already MANNICHE (2012) points out, combining the differentiated knowledge base approach with organizational theory holds a great potential to gain further insights of knowledge combination. Changing the perspective from transnational knowledge transfer to place-specific knowledge combination seems generally fruitful by exploring the territorial shaping of knowledge dynamics. Knowledge trajectories are the outcomes of simultaneous interacting dynamics at the micro- and macro-level.

The analysis underlines the important role of temporary organizing in order to induce relatedness between unrelated knowledge bases. Opening up space and providing embeddedness through co-presence for a limited duration appears as an essential coordination mechanism (TORRE, 2008), which actors use to generate shared knowledge and to establish the enabling cognitive proximity for a common understanding and the translation of meaning. The findings, however, do not support insights gained by the concept of organization proximity, which assumes that temporary geographical proximity is necessary mainly in two types of situations: for the launch of the innovative project and for the conflict management between innovators generate. Moreover, the findings do not confirm that smaller firms are more constrained by fixed co-localizations in innovation processes (TORRE and RALLET, 2005). While following innovative projects in time and space, a very dynamic and complex picture became visible. It is characterized by shifting organizational actor constellations, shifting geographical locations of the temporary embeddedness with distinct differences in the length of the duration. Actor constellations, the complexity, and uncertainty of the expected future outcome and the time horizon itself are influencing factors, which need further investigations.

The study is limited in its empirical basis and rather of explorative nature. It calls for broader and more systematic future research and cross-sectoral and cross-national comparison. Temporary organizational forms are becoming more prevalent in the globalizing economy, which underline that having access to spatial distributed knowledge sources is not sufficient to combine and integrate unrelated knowledge bases. A valuable area for future research would be the investigation of the agency to organize transience forms of temporary spatial embeddedness and thereby organizes and changes complex proximity-distance ratios in actor constellations, thus enabling knowledge combination. From a multilevel perspective, the understanding of how micro-diversity is generated and how it co-evolves with its institutional

selection environment, is the central question. Linking micro-level knowledge dynamics in innovation to aggregated macro-level structures may provide more detailed insights into the interactional and collective effects that are not only additive, but also emergent outcomes over time.

References

ABELE C. (2009) *VR China: Markt für Architekturdienstleistungen*, Köln.

ASHEIM B. (2007) Differentiated Knowledge Bases and Varieties of Regional Innovation Systems, *Innovation* **20**, 223–241.

ASHEIM B., BOSCHMA R. and COOKE P. (2011a) Constructing Regional Advantage: Platform Policies Based on Related Variety and Differentiated Knowledge Bases, *Regional Studies* **45**, 893–904.

ASHEIM B. and COENEN L. (2006) Contextualising Regional Innovation Systems in a Globalising Learning Economy: On Knowledge Bases and Institutional Frameworks, *Journal of Technology Transfer* **31**, 163–173.

ASHEIM B. and GERTLER M. S. (2005) The Geography of Innovation: Regional Innovation Systems, in FAGERBERG J., MOWERY D. C. and NELSON R. R. (Eds) *The Oxford Handbook of Innovation*, pp. 291–317. Oxford University Press, New York.

ASHEIM B. T., BOSCHMA R. and COOKE P. (2011b) Constructing Regional Advantage: Platform Policies Based on Related Variety and Differentiated Knowledge Bases, *Regional Studies* **45**, 893–904.

BAKKER R. (2010) Taking Stock of Temporary Organizational Forms: A Systematic Review and Research Agenda, *International Journal of Management Reviews* **12**, 466–486.

BALLAND P.-A., BOSCHMA R. and FRENKEN K. (2013) Proximity and Innovation: From Statics to Dynamics, *Papers in Evolutionary Economic Geography*.

BARNEY J. and FELIN T. (2013) What Are Microfoundations?, *Academy of Management Perspectives* **27**, 138–155.

BOSCHMA R. (2005) Proximity and Innovation: A critical Assessment, *Regional Studies* **39**, 61–74.

BOSCHMA R. and FRENKEN K. (2009) Some Notes on Institutions in Evolutionary Economic Geography, *Economic Geography* **85**, 151–158.

BOSCHMA R. and FRENKEN K. (2011) Technological Relatedness, related Variety and Economic Geography, in COOKE P., ASHEIM B., BOSCHMA R., MARTIN R., SCHWARTZ D. and TÖDTLING F. (Eds) *Handbook of Regional Innovation and Growth*, pp. 187–197. Edwadrd Elgar, Cheltenham.

BUNDESMINISTERIUM FÜR UMWELT (BMU) (2009) *Umweltwirtschaftsbericht 2009*, Berlin.

BUNDESMINISTERIUM FÜR VERKEHR, BAU UND STADTENTWICKLUNG (BMVBS) (2010) Bekanntmachung über die Nutzung und die Anerkennung von Bewertungssystemen für das nachhaltige Bauen, *Bundesanzeiger*, 1642–1644.

BUTZIN A. (2012) Aufbau und Forschungsprozess von Innovationsbiographien, in BUTZIN A., REHFELD D. and WIDMAIER B. (Eds) *Innovation, Raum und Kultur*, vol. 1, pp. 123–137. Nomos, Baden-Baden.

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.

CHINA GREENTECH INITIATIVE (2013) The China Greentech Report 2013: China at a Crossroads (available at: http://www.china-greentech.com/report).

COASE R. H. (1937) The Nature of the Firm, *Economica* **4**, 386–405.

COENEN L., MOODYSSON J., RYAN C., ASHEIM B. and PHILLIPS P. (2005) *Knowledge Bases and Spatial Patterns of Collaboration: Comparing the Pharma and Agro-Food Bioregions Scania and Saskatoon, CIRCLE*.

CREVOISIER O. and JEANNERAT H. (2009) Territorial Knowledge Dynamics: From the Proximity Paradigm to Multi-location Milieus, *European Planning Studies* **17**, 1223–1241.

DEUTSCHE GESELLSCHAFT FÜR NACHHALTIGES BAUEN (DGNB) (2009) *Das Deutsche Gütesiegel Nachhaltiges Bauen: Aufbau - Anwendung - Kriterien*, Stuttgart.

DEVINNEY T. M. (2013) Is Microfoundational Thinking Critical to Management Thought and Practice?, *Academy of Management Perspectives* **27**, 81–84.

EKSTEDT E., LUNDIN R. A. and SÖDERHOLM, A., WIRDENIUS, H. (1999) *Neo-industrial organising: Renewal by action and knowledge formation in a project-intensive economy*. Routledge, London, New York.

FORAY D. and LUNDVALL B. (1996) The knowledge-based economy: From the economics of knowledge to the learning economy, in FORAY D. and LUNDVALL B. (Eds) *Unemployment and growth in the knowledge-based economy*, pp. 11–32. OECD Publ, Paris.

GRABHER G. (2004) Learning in projects , remembering in networks? Communality, Sociality, and connectivity in project ecologies, *European Urban and Regional Studies* **11**, 103–123.

GRANT R. M. (1996) Prospering in Dynamically-Competitive Environments: Organizational Capability as Knowledge Integration, *Organization science* **7**, 375–387.

GRILLITSCH M. and TRIPPL M. (2013) Combining Knowledge from Different Sources, Channels and Geographical Scales, *European Planning Studies*, 1–21.

HALKIER H., JAMES L., DAHLSTRÖM M. and MANNICHE J. (2012) Knowledge Dynamics, Regions and Public Policy, *European Planning Studies* **20**, 1759–1766.

HANSEN T. (2014) Substitution or Overlap? The Relations between Geographical and Non-spatial Proximity Dimensions in Collaborative Innovation Projects, *Regional Studies*, 1–13.

HECKER A. (2012) Knowledge Beyond the Individual? Making Sense of a Notion of Collective Knowledge in Organization Theory, *Organization Studies* **33**, 423–445.

HEGNER H.-D. (2009) Leitmotiv: Nachhaltiges Bauen, in Bundesministerium für Verkehr Bau und Stadtentwicklung (Ed) *Zukunft bauen: Das Magazin der Forschungsinitiative Zukunft Bau*, vol. 1, pp. 18–19, Stuttgart.

HEILMANN S. (2004) *Das politische System der Volksrepublik China*. VS Verl. für Sozialwiss, Wiesbaden.

HOWELLS J. (2001) The nature of innovation in services, in Organisation for Economic Co-operation and Development (OECD) (Ed) *Innovation and Productivity in Services*, pp. 57–82. OECD Publishing, Paris.

JONES C. and LICHTENSTEIN B. B. (2008) Temporary Inter-organizational Projects: How Temporal and Social Embeddedness Enhance Coordination and Manage Uncertainty, in CROPPER S., EBERS M. and HUXHAM C. (Eds) *The Oxford handbook of Inter-Organizational Relations*, pp. 231–255. Oxford Univ. Press, New York.

KOGUT B. and ZANDER U. (1992) Knowledge of the Firm, Combinative Capabilities, and the Replications of Technology, *Organization science* **3**, 383–397.

MANNICHE J. (2012) Combinatorial Knowledge Dynamics: On the Usefulness of the Differentiated Knowledge Bases Model, *European Planning Studies* **20**, 1823–1841.

MARCH J. G. (1991) Exploration and Exploitation in Organizational Learning, *Organization science* **2**, 71–87.

MARTIN R. and MOODYSSON J. (2013) Comparing Knowledge Bases: On the Geography and Organization of Knowledge Sourcing in the Regional Innovation System of Scania, Sweden, *European Urban and Regional Studies* **20**, 170–187.

MATTES J. (2012) Dimensions of Proximity and Knowledge Bases: Innovation between Spatial and Non-spatial Factors, *Regional Studies* **46**, 1085–1099.
MAYRING P. (2000) Qualitative Inhaltsanalyse, *Forum Qualitative Sozialforschung. Theorien, Methoden, Anwendungen* **1**.
MOULAERT F. and SEKIA F. (2003) Territorial Innovation Models: A Critical Survey, *Regional Studies* **37**, 289–302.
NELSON R. R. and WINTER S. (1982) *An Evolutionary Theory of Economic Changes.* Harvard University Press, Cambridge, Mass., London.
NERLAND M. and JENSEN K. (2012) Epistemic practices and object relations in professional work, *Journal of Education and Work* **25**, 101–120.
NONAKA I. and TAKEUCHI H. (1995) *The knowledge Creating Company.* Oxford Univ. Press, New York.
NONAKA I., TOYAMA R. and NAGATA A. (2000) A Firm as a knowledge-creating entity: A new Perspective on the Theory of Firm, *Industrial and corporate change* **9**, 1–20.
NOOTEBOOM B. (2010) *A Cognitive Theory of the Firm: Learning, Governance and Dynamic Capabilities.* Edward Elgar, Cheltenham.
NORDHAUSE-JANZ J., WELSCHHOFF J. and REHFELD D. (2011) *Innovationsstrategien am Bau im internationalen Vergleich*. BMVBS-Online-Publikation 7.
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD) (2010) *New Nature of Innovation.* No Publ., Copenhagen.
POLANYI M. (1966) *The tacit dimension.* Doubleday, Garden City, NY.
RENNINGS K., RAMMER C., OBERNDORFER U., JACOB K., BOIE G., BRUCKSCH S., EISGRUBER J., HAUM R., MUßLER P., SCHOSSIG C. and VAGT H. (2008) *Instrumente zur Förderung von Umweltinnovationen: Bestandsaufnahme, Bewertung und Defizitanalyse*, ZENTRUM FÜR EUROPÄISCHE WIRTSCHAFTSFORSCHUNG GMBH (ZEW); FREIE UNIVERSITÄT BERLIN, Berlin.
RICHERZHAGEN C., FRIELING T. v., HANSEN N., MINNAERT A., NETZER N. and RUßBILD J. (2008) *Energy Efficiency in Buildings in China: Policies, Barriers and Opportunities.* Deutsches Institut für Entwicklungspolitik, Bonn.
ROBERTS J. (2000) The Internationalisation of Knowledge Intensive Service Firms, in ANDERSEN B., HOWELLS J., HULL R., MILES I. and ROBERTS J. (Eds) *Knowledge and Innovation in the new service economy*, pp. 159–177. Edward Elgar, Cheltenham. Northampton.
SADELER C. (2011) Die Wachstumsdebatte in China (available at: http://www.boell.de/oekologie/gesellschaft/oekologie-gesellschaft-nachhaltiges-wirtschaftswachstum-china-debatte-green-growth-11907.html).
SCHLESINGER D. M. (2006) Internationale Märkte für Umweltschutztechnologie, in HAAS H.-D. and NEUMAIR S. (Eds) *Edition internationale Wirtschaft*, pp. 491–510. Oldenbourg, München.
SCOTT W. R. (2001) *Institutions and organizations.* Sage, Thousand Oaks.
STRAMBACH S. (2008) Knowledge-Intensive Business Services (KIBS) as drivers of multilevel knowledge dynamics, *Int. J. Services Technology and Management* **10**, 152–174.
STRAMBACH S. and HALKIER H. (2013) Reconceptualizing Change - Path Dependency, Path Plasticity and Knowledge Combination: Editorial, *Zeitschrift für Wirtschaftsgeographie* **57**, 1–14.
STRAMBACH S. and KLEMENT B. (2012) Cumulative and Combinatorial Micro-dynamics of Knowledge: The Role of Space and Place in Knowledge Integration, *European Planning Studies* **20**, 1843–1866.

TÖDTLING F., ASHEIM B. and BOSCHMA R. (2013) Knowledge Sourcing, Innovation and Constructing Advantage in Regions of Europe, *European Urban and Regional Studies* **20**, 161–169.
TOLBERT P. S. and ZUCKER L. G. (1996) The Institutionalization of Institutional Theory, in CLEGG S., HARDY C. and NORD W. R. (Eds) *Handbook of Organization Studies*, pp. 175–190. Sage Publications, London, Thousand Oaks.
TORRE A. (2008) On the role played by temporary geographical proximity in knowledge transmission, *Regional Studies* **42**, 869–889.
TORRE A. and RALLET A. (2005) Proximity and Localization, *Regional Studies* **39**, 47–59.
TRIPPL M. and TÖDTLING F. (2012) Regionale Innovationssysteme, in BUTZIN A., REHFELD D. and WIDMAIER B. (Eds) *Innovation, Raum und Kultur*, vol. 1, pp. 91–107. Nomos, Baden-Baden.
TURVANI M. (2010) MICROFOUNDATIONS OF KNOWLEDGE DYNAMICS WITHIN THE FIRM, *Industry & Innovation* **8**, 309–323.
YANG X. (2011) Anting German Town: Chinas deutsche Geisterstadt (available at: http://www.spiegel.de/reise/staedte/0,1518,783475,00.html).