

SUMMARY:
Innovation Biographies in the Construction Sector

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1 Introduction

The construction sector is traditionally known as a low-tech sector that is characterised by low innovative activity and high innovation barriers. Amongst the latter are narrow budget and time-frames in construction projects and the large share of small enterprises in the value chain. The industry's spatial and sectoral fragmentation too, hinders the diffusion of knowledge and innovation because communication channels are not well established. Rather than the construction industry itself, suppliers, architects and construction engineers account for the major innovative activity in the sector. These aspects are barriers to a systematic grouping of innovations and are considered as an "innovation gap" in innovation research (Taylor 2005).

Currently, construction companies face the challenge of re-designing their operational and inter-operational boundaries. By developing service-oriented market strategies, companies aim to adjust to changed customer needs. At the same time general conditions change due to demographic changes, an increased awareness regarding sustainable and energy efficient construction, the further internationalisation and a growing pressure on the regulation system which is of central importance for the construction sector. The consequence is that not only individual companies need to find a new position, it is rather the entire sector which needs to re-organise.

These observations were the starting point of the study "Innovation Biographies in the Construction Sector" which's main findings are summarised in this paper. The study's aim was to get new insights into the dynamics of innovation processes in the construction sector in order to draw consequences for a mission statement for the sector's value chain. Apart from an international state of the art analysis of innovation in the construction sector, ten innovation biographies were carried out. The latter were analysed in regard to the following questions:

- Who are the main actors in the innovation process?
- How was the process anchored within the innovative company and among the participating companies?
- What are the organisational and social aspects that influence the development and diffusion of innovations?
- Which are the central barriers to innovation processes?

The paper is structured as follows: Summary of the main findings of the state of the art analysis of innovation in the construction sector [2]. Introduction of the methodology "innovation biographies" and illustration of the investigated innovations in the sector's value chain [3]. Discuss of the study's main results [4] and formulation of recommendations for a mission statement for the construction sector from an innovation-related point of view [5].

2 Innovations in the construction sector

In order to understand innovative behaviour in the construction sector it is possible to analyse the interplay between company-related innovation factors and innovation factors of the wider environment of a company (Seaden et al. 2003). According to Dubois/Gadde (2002: 621) company-related innovation factors with a negative influence on innovative behaviour are:

- A short-termed perspective during construction projects which results in suboptimal solutions and hinders the technical development of innovations;
- A failure of adapting organisational and technical concepts of other value chains in order to increase productivity;
- The shortage of collaboration with suppliers and a lacking supply chain management;
- The industrialisation of production which stays behind technical and organisational opportunities.

Innovation research often neglects the influence of environment-related innovation factors, not only in the construction sector (cp. Hartmann 2006: 571ff). Among the most important environment-related innovation factors are (cp. Hartmann 2006: 571ff):

- The influence on the problem-solving and diffusion potential;
- The construction's dependence on customer expectations and local situations;
- The way of collaborating with the customer and the customer's attitude towards innovations;
- Financial power, time pressure and extent of regulations.

In comparison to companies of other branches, construction companies rarely use internal resources to initiate innovations (cp. Reichenstein et al. 2005: 638f). One result of the lacking mobilisation of internal resources is a diminished ability to realise and adapt external innovative impulses. However, this is crucially important in low-tech sectors as mechanisms of knowledge searching, identification and validation are more important than basic research. Consequently, the collaboration between construction companies and research institutions should be evaluated differently from the collaboration between high-tech companies and research institutions (Tunzelmann/Acha 2005).

A survey of the Australian road construction sector underpins the importance of internally generated impulses in the context of new technology application. Accordingly, above average innovative companies have strategic particularities in comparison to companies which are below average: They normally apply a human resource strategy which implies the recruitment of job starters, they have technical abilities as a pre-condition to quickly adapt innovations coming from the market and they implement new technologies as a result of internal R&D (Manley/McFallan 2006). However, many small and medium sized companies do not have systematised R&D-departments. Thus, they are not able to develop new technologies and processes. In order to balance out the lacking internal R&D activities, two company characteristics are of major importance: qualified employees and the ability to implement external innovations into specific projects.

Besides the company and environment-related innovation factors, diffusion mechanisms of innovation play an increasing role in innovation research. Therefore, three further aspects shall be underlined in addition to the questions formulated in the introduction:

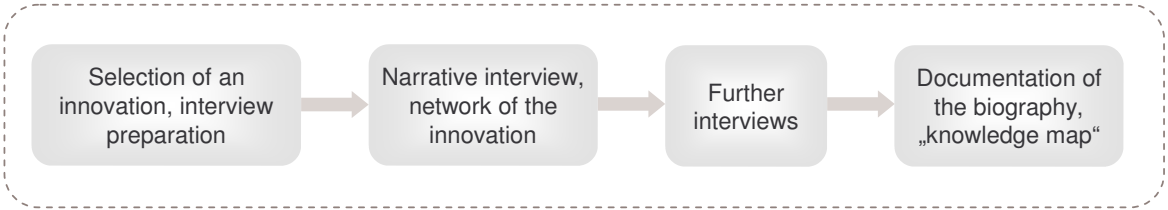
- The first aspect is about the above mentioned internal capacity to adapt innovation. In this regard, on-the-job-training, technical support and technological competences are key resources of the implementation of technical and organisational innovations. Furthermore, in this context empirical studies stress the supporting role of the company's management (Peansupap/Walker 2006, Nam/Tatum 1997).
- Customer values and cultures in the value chain form the second aspect (Ling 2003). It is argued that the initiation of change processes in the value chain faces particular barriers, because changes are not compatible with the norms of the dominant communities of practices (cp. Dubois/Gadde 2002: 627). Therefore, a further research issue is about the specific innovation paths of the construction sector. The fragmentation of the construction sector's value chain might affect innovation paths.
- A third aspect refers to the environment of innovations. In particular, small and medium sized enterprises are constrained by their limited capacities and rely upon a supporting environment which facilitates the diffusion of knowledge and innovation (Sexton/Barrett 2003).

3 Innovation biographies – methodology and procedure

Innovation biographies take into account the procedural and inter-linked character of innovations. The objective of innovation biographies is to capture an innovation process from its beginning until its implementation. This is carried out by talking to persons who are/were central for the innovation process. In so doing the process is re-constructed including its milestones, barriers and drivers. Based upon this, specific problems of the construction companies in the innovation processes are identified. One further component of the analysis is a graphical illustration of the innovations pattern (a "knowledge map"). Through the visualisation new insights into the development and diffusion of innovations can be derived.

Methodologically innovation biographies follow a three-step procedure: firstly, the interviewee tells the entire “life-story” of a selected innovation during a narrative interview. The focus here is on knowledge interactions and the contribution of the different actors being involved. Through the narrative interview, the biography with all its connections inside and outside the company becomes visible. Secondly, building upon the identified inside and outside connections, further interviews are conducted in order to enrich and complete the findings from the narrative interview. Innovation biographies end with the above mentioned documentation and visualisation of knowledge flows in a knowledge map which also contains the drivers and barriers of the innovation process. The following figure illustrates the research procedure of an innovation biography.

Figure 1: research procedure innovation biography



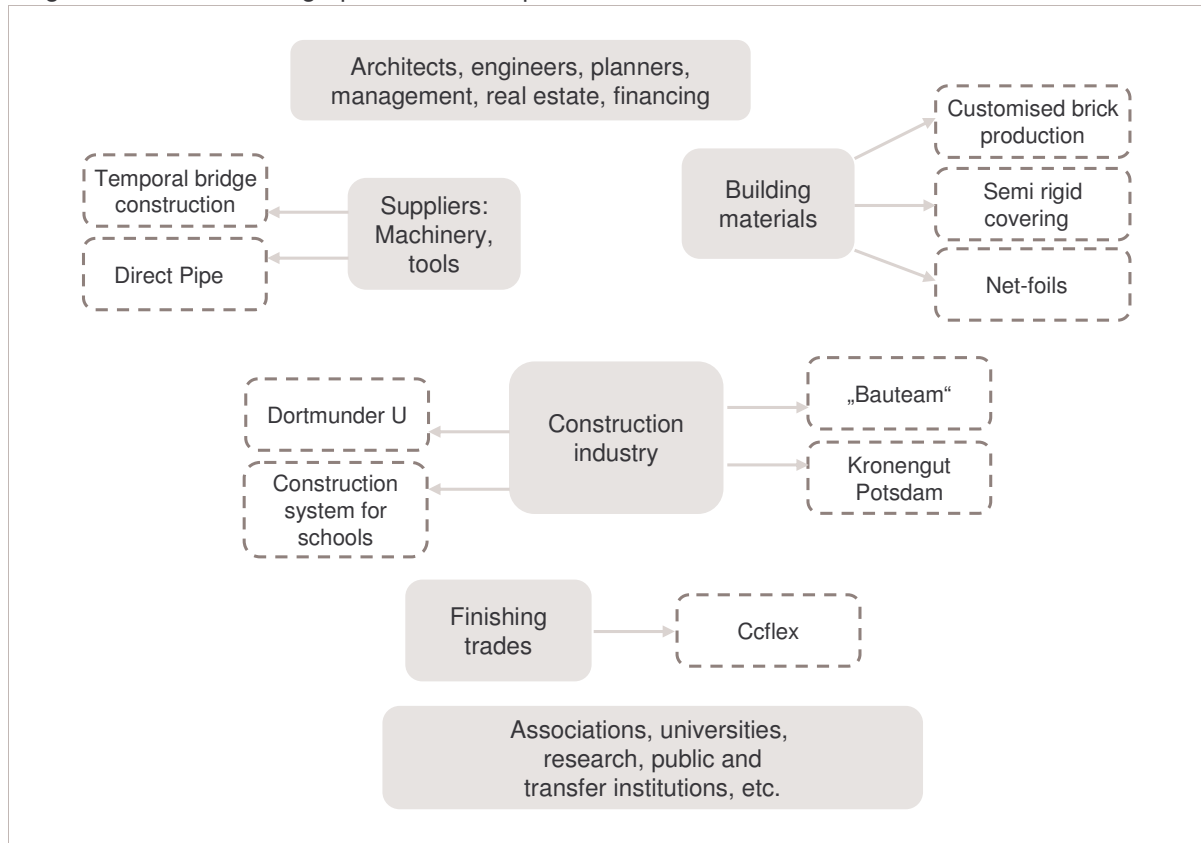
In the course of the study, ten innovation biographies were selected along the construction sector's value chain. In order to adjust the methodology to the characteristics of the construction sector, we distinguished between innovation (suppliers) and project biographies (construction industry). The table in figure 2 illustrates the analysed innovation and project biographies and the company in which they were developed.

Figure 2: Companies and selected innovations/projects

Innovation biographies	
<i>Company/Institution</i>	<i>Innovation/Project/Interview</i>
Echterhoff	Temporal Bridge Construction
Herrenknecht	Direct Pipe
Fachhochschule Bielefeld	Net-Foils
Hagemeister	Customised brick production
Straßen.NRW	Semi-rigid covering
Evonik	Ccflex
Project biographies	
Goldbeck	Construction system for schools
Assmann Planen und Beraten	Dortmunder U
Werkgruppe 1	Bauteam
Kessler Bau	Kronengut Potsdam

The primary objective of the interviews was to grasp the interactions of innovation processes inside the company and among the participating companies. Furthermore, it was aimed to work out the innovation's distribution/diffusion within the value chain. Therefore, main actors and organisational and social aspects that influenced both the development and diffusion of the innovation were central during the interviews. Altogether, we covered innovations with origins in different parts of the value chain: civil engineering, construction machinery and material, finishing trades and construction industry. Figure 3 illustrates the selected innovations and projects at their respective position in the value chain. In the next chapter we will introduce the innovation biographies' results. By reason of the small number of biographies these results are not representative. This was balanced out through additional expert interviews and discussions of the project's steering committee. The adjustment made possible to formulate statements of a more general character.

Figure 1: Innovation biographies and their position in the value chain



4 Results of the empirical study (innovation biographies)

The most important study results are summarised according to the research questions and the issues raised in the state of the art analysis. They are structured along these topics:

- Customers and Regulations – The environment of Innovations;
- Organisation of Innovation;
- Space for Innovation;
- Cooperation, Communication, Barriers;
- Knowledge, Competitive Advantage, Diffusion.

Customers and regulations – the environment of innovations

Usually, the initiative to carry out innovative activity arises within a company. However, as innovations depend on market acceptance, early users (customers) who adopt the innovation are a crucial precondition. As lead-customers customers can even have a considerable influence on a company's innovative activity. Although less tangible, the interview partners underpinned the importance of customer values. In this context it was pointed out that project managers with a business administration background have gained in importance during the last years. This has complicated the communication between the engineering oriented building contractors and the business management minded customers.

Regulations as a further component of the innovations' environment were evaluated differently by our interview partners. For instance, regulations such as the energy savings regulation can open up new challenging markets. They increase the pressure to develop innovative products and consulting services. On the other hand, regulations are considered as barriers to innovation because they complicate their implementation process.

Organisation of innovation

There exists no standardised procedure of innovation development in the consulted companies. Whenever necessary, it seems to be more appropriate to spontaneously build a team or small working cells. However, it is noticeable that formal projects such as piloting actions and publicly funded projects did play an important role in many of the analysed innovation processes. The integration of an external actor (i.e. a customer or the federal ministry of education and research) usually functions as a “catalyst” in the innovation process. It increases the pressure to carry out results and raises the innovation’s priority inside the company.

Most of the analysed innovations originated from the necessity to optimise existent practises within the company. Therefore, the development was largely realised on an internal basis. To facilitate the company-internal knowledge exchange frequent innovation meetings or similar communication events took place.

Space for innovation

Apart from the communication events, formalised knowledge and quality management seemed to be not well-established. In fact, successful innovation processes relied upon individual employees who often played a decisive role. These “facilitators” are normally responsible for the innovation, have considerable knowledge about the sector and contacts to external organisations. Furthermore, they have a specific characteristic which is best labelled as “entrepreneurship”. Entrepreneurship implies having a certain degree of openness regarding new ideas, readiness to assume risk as well as the ability to motivate and integrate other employees.

The innovative potential of employees is not fully exploited, yet, although the consulted companies underlined the importance of qualified employees. The knowledge and experience of employees has an effect in situations where unexpected problems require efficient solutions. In such situations project management software has limitations. Therefore, our interview partners evaluated software as an accompanying tool rather than as a central element in the construction/innovation process.

Cooperation, communication, barriers

Contrary to innovations in the supplier industries, innovative projects of the construction industry tend to be more openly. In these projects, different competences (engineering, manufacturers, etc.) are integrated as early as possible. However, communication beyond the borders of the project participants tends to take place only sporadically. This observation corresponds with the impression of the fragmentation of the construction industry’s value chain and under-developed communication channels.

Some of the typical innovation barriers are a result of the construction industry’s specifics. These are the long durability of buildings and infrastructures which imply a long probation period of innovations. The individuality of construction projects too, requires flexibility and confines a pre-set planning structure. In this context, the regulatory framework is inevitable a subject of discussion: On the one hand regulations do guarantee orientation and reliability. On the other hand regulations require innovations to be proved and tested enormously, before they get integrated into construction projects.

Concerning systematisation and industrialisation strategies as well as the work in construction teams, it becomes apparent that the official framework of trades and guilds requires particular revision. It seems more appropriate to work towards a trade-integration rather than continuing to uphold the current separation of trades and competences. Moreover, it diminishes the continuity of the work flow.

Knowledge, competitive advantages, diffusion

Independently from the innovation’s nature (product, process, organisational) the companies were conservative regarding the diffusion of new knowledge. For instance, there were only little patent applications, since a large share of the innovations was incremental and had a comparatively low degree of novelty. Additionally, some of our interview partners did not apply for patents intentionally, because of nondisclosure issues and bad experiences from former patent applications.

This has consequences regarding the diffusion mechanisms of an innovation which vary according to an innovation's nature. In many of the process and organisational innovations diffusion channels were weakly developed. The companies had no interest to provide access to the innovation as this would reduce their competitive advantages. The consequence of this restrictive behaviour is that the innovation is only applied when the developing company is part of a construction project's consortium. Diffusion mechanisms of product innovations differ as they are either sold or rented out by the innovative company. The success of the innovation is only achieved when the product undergoes broad market diffusion. This by no means implies that the knowledge necessary for the production of the innovation is disclosed as well.

5 Conclusions for the further development of innovations in the construction sector

The company's overarching motive to be innovative was to optimise their processes in order to reduce costs. In this sense innovations were seen as an instrument to set apart from other competitors.

In the context of a mission statement for the construction sector, innovation should not be considered as an aim in itself and, instead, should relate to societal progress. The construction sector should be viewed as an innovation implementing economy which aims at designing the social environment, sustainability and quality of life.

Furthermore, it is important to consider the innovations that were carried out within the construction sector's value chain. This perception accounts for the structural specifics of the construction sector because innovation is largely generated in the supplier industries and not in the construction industry. Nevertheless, it is still important to work towards reducing the sector's innovation weaknesses: both in the fields of innovation management and innovation diffusion remains considerable need to catch up with other branches.

Consequently, companies have to realise the benefits of initialising innovation supporting activities. Among these activities is the development of a business strategy to penetrate the market which is most often not present in small and medium sized companies. Both market and cost pressure captures their resources and hinders a necessary strategic development. The latter is crucial for innovations to have long-term effects that are embedded in the overall business strategy. Moreover, it requires learning processes which can only be effective when meeting a fruitful organisational basis.

Especially small and medium sized companies have difficulties to accept that innovations are increasingly the result of complex development processes in which several actors collaborated. This in turn means that companies who want to carry out innovations need to have access to networks which can provide complementary competences. In this context communication and cooperation are pre-conditions to establish access to networks. This also includes cooperation and cooperation across trades as a mechanism to diffuse innovations.

For customers too, the application of innovations is connected to uncertainty and risk. Competitive and innovative value chains rely upon demanding lead markets and lead customers, which are willing to take the risk. But the public sector, construction associations, infrastructure operators as well as the regulatory framework can also provide impulses for innovation. Service orientation as a common problem solution could be a mission statement, also for contracting entities in the construction sector.

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