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INNOVATION MANAGEMENT IN PROJECT ORIENTED COMPANIES

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Abstract. Innovations as main tools that enable competitive advantage are crucial for business success of any enterprise. Therefore, they should be fostered systematically. The environment and the organisational culture within the enterprise should encourage the individuals as well as groups to create, express and develop the ideas into innovative products and services that yield an additional value. Providing support to the desired organisational culture in project oriented company, such as construction contracting company, is a challenging task due to constantly changing working groups and the environment. The paper identifies the challenges and drivers of innovation in project oriented companies and discusses measures to be taken in order to facilitate technological and organisational innovations by using literature survey. Selected case studies of tehnological and organisational construction innovations are presented and analysed.

Keywords: construction sector, innovation management, drivers and barriers of innovation, technological innovations, public-private partnerships.

JEL classification: O32.

1. Introduction

Developing new products and services, that is vital for survival of any enterprise, is possible only if inventions and innovations are constantly proposed and implemented. Innovation is a consequence of the invention, usually marked by first use of a new product or service in manufacturing or in a market that ends in a product or service with the added value. Enhancing existing, and developing new products and services enable the company to improve its competitiveness and market position, which results, in the next step, its long term existence and growth (Palčič *et al.* 2010; Banyte and Salickaite 2008). Innovative accomplishments can include any policy, structure, method or process, product or market opportunity that was perceived to be new in the company (Nohria and Gulati 1996; Felekoglu and Moultrie, 2014). Traditionally, innovations have been attributed to individuals who managed to convert their idea into practice. Today, it is clear that an innovation management is a complex system within which various complementing parts of knowledge are available. In order to exploit this knowledge and arrive to an innovation, cooperation of several individuals is a must (Innovation Management 2004). Efficient innovation management is consequently of paramout importance for business succes of any enterprise, including those that carry out most of their activities within projects.

Project based enterprises are becoming increasingly important in contemporary business environment. Although they may often respond well to the business needs of the clients, they are associated with several managerial challenges, including those in innovation management field. The purpose of the paper is, therefore, to identify challenges related to innovation in project oriented companies, and identify measures to be taken in order to facilitate technological and organisational innovations. Within the context of project oriented enterprises, special attention will be devoted to construction companies. Literature survey will be used as the research method for these topics.

The last goal of the paper is to determine the relationship between innovation management in a company and clustering of organizations, therefore the focus is placed to the role of clusters as facilitators of innovations in the construction industry. For this purpose, the hypothesis that clusters are stimulating the emergence of innovations is established and tested.

The paper is structured in the following way. First, types of innovations are presented, their specific features and the ways they are implemented, together with barriers for their implementation in practice. Challenges related to innovation management in project oriented industry, in particular in the construction, are identified on the basis of literature review and presented in the next section. Specific features of innovations in construction are identified in the next section, accompanied by identification of drivers and barriers specific for this sector. Examples of both technological and non-technological construction innovations are presented. Discussion and conclusions derived from the presented research are presented in the last section of the paper.

2. Types of innovations

Innovations can be divided into technological, where a new, or improved product is developed, and nontechnological (Fig.1) (Blayse and Manley 2004). The improved product should respond to the changed or augmented requirements of the potential buyer, or induce a new need; or, alternatively, it should bring competitive advantage to the producer by resulting in the production of the same product at a lower cost. Conversely, non-technological innovation type leads to an organisational change within the enterprise, leading to leaner, more rational work processes, while producing the same product, or offering the same service. The organisational change can also be introduced on interorganisational level, i.e. it leads to new ways of interactions among enterprises that take part in the production of a certain product or service. This offers a competitive advantage as well.

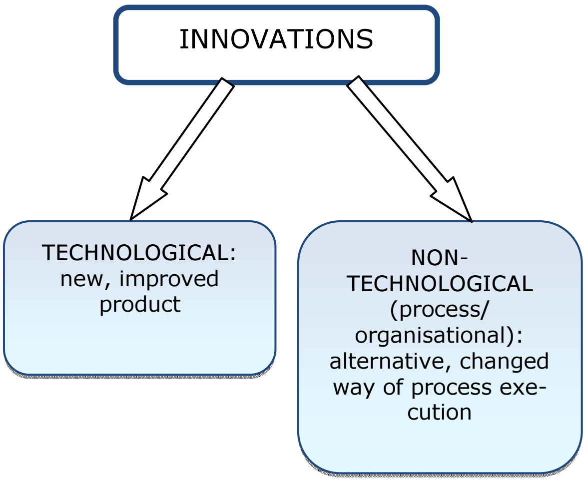

Fig. 1. Types of innovations with respect to their nature

Therefore, in addition to R&D units, where new products or their components are developed, companies striving to production processes optimization encourage personnel to identify work flow obstacles, less productive practices and other internal work elements that could be improved. Although less visible than product innovations that are usually clearly noticed by the consumer, the process/organisational (non-technological) innovations have the potential of bringing significant benefits to the enterprise due to improved cost and/or resource efficiency of the processes.

The allure of non-technological innovations is hidden also in the fact that, in contrast to technological innovations, the required investment in R&D activities is relatively small. Nevertheless, the indirect costs related to lost work-hours due to changes of organisational structure and associated work processes should not be neglected when such changes are introduced into the everyday operation of the company.

The second division of innovations distingushes radical (where a product, significantly different from the existing ones, is created), and incremental innovation, by which an existing product is improved (Jones and Saad 2003). Radical innovations are associated with large uncertainties. They focus to products, processes or services that have so far not exhibited chances of success. Contrary to radical innovation, incremental innovation typically bears low uncertainty, builds on existing technologies, and often focuses to improved selected properties of the product, or improved cost efficiency (Jones and Saad 2003).

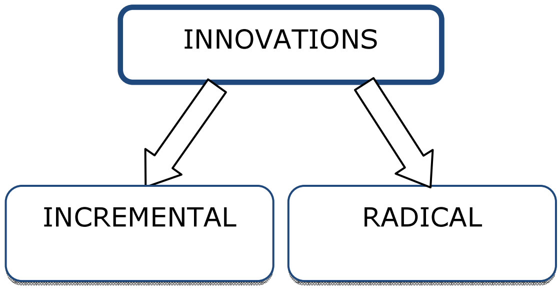

Fig. 2. Types of innovations with respect to their advancement

Various industrial sectors have developed different approaches to fostering innovation and its management. Approaches differ due to varying rate of innovation activities, availability of funding, legislative requirements related to the final product as well as the production processes, variances in culture and approach in various industrial sectors and/or different countries, tax vehicles imposed by the governments, product market maturity, varying level of supply chain stability, intellectual property rights protection etc. (Innovation 2004).

Within construction, Slaughter (1998; 2000) defines the following construction innovation types: modular and architectural innovations. Modular innovations may be developed within organisations and implemented within minimum of negotiations with parties involved, while architectural innovation requires change and modification in the set of interacting components and systems.

3. Innovation management in enterprises: literature review

There is a vast body of scientific literature on innovation management and its implementation in a company, e.g. Ciganak *et al.* (2014); Hsu and Chuang (2014); Kim *et al.* (2011); Palčič *et al.* (2010); and Cavusgil *et al.* (2003), to name just a few recent relevant works. Various aspects of innovation management were studied. Ciganak *et al.* (2014) examined the issue of timeliness of decision to adopt an innovation in an enterprise that may significantly affect the level of revenue and increased market share, leading to augmented business performance of the enterprise.

Hsu and Chuang (2014) carried out empirical research on technology spillovers and innovation for a group of high-tech companies, and discovered that performance of these companies was positively affected by their R&D efforts and presence of multinational corporations. Kim *et al.* (2011) focused their attention to SMEs in IT-related business. The conducted empirical study concluded that R&D intensity is not the only factor that influences the innovation performance of companies.

Palčič *et al.* (2010) studied technical and non-technical innovations aiming to modernize manufacturing processes for a sample of manufacturing enterprises. The results showed that there is a difference in utilising innovation concepts between low, medium and high tech industries. Since knowledge management within an enterprise can form a partial basis for innovation generation, some researchers studied simultaneously innovation and knowledge management. Conditions within the company, the ways tacit knowledge is created and transferred, and how it affects innovation capability of the company was studied extensively by Cavusgil *et al.* (2003). Wang *et al.* (2010) studied factors that can affect R&D activities, in particular uncertainty, and developed a risk management framework that aligns project risk management with corporate strategy. Implementation of this framework leads to achieving the firm goals. Risk management was studied also by other researchers, e.g. Colarelli *et al.* (2008), who surveyed management practices that were identified as having potential to contribute to the success of radical innovation efforts in large established firms. In addition to research publications, several practically oriented guidelines on innovation implementation in practice, e.g. Innovation (2004) are available as well.

From the literature review, it can be seen that the majority of research endeavours focuses to innovation management in process and service industry while only a few researchers address the question how to implement innovation management in project oriented sectors.

4. Challenges related to innovation management in project oriented industry

The first challenge in innovation management in project oriented enterprises is related to slack resources that the majority of innovation management researchers deem to be necessary if innovations are supported by the top executives (Nohria and Gulati 1996). The concept of the project oriented work, being time and resource limited, may contradict with the availability of slack time (deemed necessary for innovation initialization), thus limiting the opportunities for either process or product innovation. The second question is whether project oriented companies provide a supportive environment for innovations and whether they see innovations as universally desirable (Keegan and Turner 2000), due to strong emphasis to achieving the project goals.

For traditional project-oriented companies with clearly expressed safety culture such as construction contracting companies, other obstacles have been identified, as well. In particular, we should mention separate design and construction of structures, conservative organisational culture within both contracting and design companies, and the legislature that may restrict innovations.

Design and construction of structures are traditionally performed by different business entities (design office and general contracting company) that, in some cases, have no contractual relations as both mentioned stakeholders sign the contract with the client. This means that their relationship may not contain feedback from the other party's side that could lead to transfer of contractor's and design engineer's past experience into the current project. Separate design and construction may present a serious challenge for the implementation of improved or new solutions into the design practice. In addition, legislature may not allow innovative technical solutions that have not been sufficiently verified in practice, in order to ensure safety of the structure and protect the final user of the structure.

Blayse and Manley (2004) identify additional challenges in fostering construction innovation: clients and procurement systems. Clients determine the ways the structure will be procured, as well as approve innovative design, and procurement rules (defined already in the initialization phase) define the designer and contractor selection procedure together with their rights and duties. It is obvious that both factors can influence the level of technological and nontechnological innovations.

Comprehensive research carried out by Manley *et al.* (2009) by using survey showed that the Australian construction companies, identified as being highly innovative, used the following business strategies:

– investing in R&D;
– participating in partnering and alliance in projects;
– ensuring that project learnings are transferred into continuous business processes, and
– recruiting new graduates.

A summary of identified challenges is presented in Table 1.

Table 1. Identified challenges related to construction innovation (source: compiled by author)

No	Challenge
1	Slack time
2	Environment supporting innovations inside the company
3	separate design and construction
4	Legislature
5	Organisational culture
6	Safety culture in civil engineering
7	Clients
8	Procurement models being employed

5. Existing practice within construction innovation management: barriers and drivers to innovation uptake

Construction sector is usually perceived as conservative, where innovations are difficult to implement. Typically, construction project is resource consuming and takes a relatively long time to be completed, therefore, there might be possibilities to include innovation management in the project. Challenges identified in the previous section will therefore be evaluated in terms of their influence upon innovation uptake within construction project.

The first identified challenge, slack time, or, to be more precise, its sufficient availability, can represent a serious obstacle. Project orientation and limited resources and comprehensive resource planning often do not allow the employees having extra time to be spent on inventions and innovations. This specific feature of construction projects may represent a serious barrier to innovation generation.

Internal environment, as the secondly identified challenge, may beneficially influence the uptake of innovations in construction contracting company when fostered in an adequate way. General positive attitude to implementation of innovation into an organisation may encourage the individuals to identify and propose new, improved ways of execution daily tasks. Practice, however, often shows that contractors are reluctant to change their routine operations if these seem to be working efficiently. Therefore, internal environment can be, in majority of cases, considered a barrier to innovation uptake.

Design and construction carried out by different business entities that have no contractual relationship can hinder transfer of existing knowledge among project partners. If design engineer does not get the feedback from the construction site by an established procedure, the subsequent design may contain the same solutions as in the past that have not been proved as efficient. Therefore, separate design and construction contractual model can be considered as a barrier to innovation generation within the project. Having said that, it also has to be acknowledged that other business models, such as design-build contract model, where the client signs a single contract with the contractor, can be beneficial for knowledge transfer among project partners for a particular project. The challenge remains with transfer of knowledge and past experience from one project to another within the contracting company, which can be difficult even when it is supported with contemporary IT tools (Udaipurvala and Russel 2002; Tserng and Lin 2004).

Legislative requirements related to design, construction and use of buildings and engineering structures were issued in order to protect public interest and users of these structures. As such, they reflect the current level of knowledge and define the framework to be respected by all construction project stakeholders. Consequently, from the viewpoint of innovation management, they can be considered as a barrier to innovation implementation.

The conservative organisational culture that is present in civil engineering enterprises can be explained by the fact that safety of buildings and other structures is of paramount importance, as structural damages of the buildings may lead to loss of human lives and health. This culture does not favour fast changes and emphasizes hierarchy within the enterprise. To a certain extent, it is related to the size of the typical projects the company carries out.

Professionals working in contracting companies, as well as structural design and survey engineers, are aware of the possible consequences of their decisions. They are educated in an atmosphere where safety of people comes first: structures should be designed and built in a way that ensures their adequate structural safety. Contemporary structural design codes reflect this attitude, supported by the state-of-the-art knowledge.

Examples of serious earthquake-induced structural damage of residential buildings that should occur only at extreme earthquake load, are presented in Fig. 3. Depicted damaged buildings were constructed prior to acceptance of contemporary design codes. The safety culture is clearly deeply embedded into education, professional training and everyday practice of the structural engineer. It is vital for the safety of the user, however, on the other hand; it may hinder the innovation acceptance and its uptake.

In order to advance in technological terms, design and construction procedures used by the civil engineers are, due to before mentioned safety culture, extensively tested before being officially approved and allowed to be applied in practice.

For example, one of the most recent radical technological innovations in the field of construction materials is self-compacting concrete, i.e. concrete that needs no compacting (vibrating) after being placed into the formwork. Due to this particular property, the work process of compacting (which poses health hazards to the workers, and prolongs the total time of concrete structure execution) can be omitted. Composition of self-compacting concrete needs to be carefully designed and executed in order to achieve the required properties (El-Chabib and Syed 2013; Diederich *et al.* 2013). Adequate flowability needs to be ensured in order to enable the casting process. Simultaneously, resistance to segregation of fresh concrete needs to be ensured and uniform structure of hardened concrete needs to be achieved as well. Special additions enabling these properties have to be used in the concrete mixture, and several quality management procedures need to be respected during concrete production if self-compacting concrete is to perform as designed during the use phase.

Another case where extreme care needs to be devoted to the installation of construction products, due to their significant influence upon structural safety, are prestressed geotechnical anchors. Testing that needs to be carried out prior to their actual installation can be extensive and time-consuming, and can be considered a barrier to the implementation of this complex innovative product.

Prestressed geotechnical anchors are a construction product that is (during its use) permanently built-in the soil. One end of the cable is held together by a trumpet-shaped head, and the other one is grouted into the soil. This geotechnical load-bearing threaded element enables transfer of forces from the structure to the soil, and therefore, its adequate performance is crucial for long-term safety of the complete structure. Once installed, metal-tensioned systems are vulnerable to corrosion and/or loss of anchorage: however, these structural deficiencies can not be observed visually.

a) b) c)

Fig. 3. Foundations of safety culture, dominant in construction field: a) earthquake-induced structural damage of a residential building, resulting from Čezsoča earthquake (2004), b) earthquake-induced failure of the short flexurally loaded beam above entry door (2004); c) location of Čezsoča on earthquake magniture map of Slovenia.

Since the replacement of anchors once installed is almost impossible, monitoring of anchors, once built–in the ground, is a must. Therefore, the anchors (Fig. 4) are equipped with sensors prior to their final installation so that monitoring is enabled. (Rotar 2009)

Fig. 4. Standard anchor (Rotar 2009)

Due to demanding geotechnical conditions, geotechnical anchors were used in several structures constructed within the Slovenian highway construction programme that was carried out in the period from 2004 to 2009. Although they have been already tested and certified in other countries, the General Contractor was required to obtain the Slovenian Technical Approval before the product was allowed to be used in practice by the Engineer. The procedure to obtain the approval consisted of several tests, including execution of the test fields (Fig.5), and typically took more than one year (Rotar 2009).

Fig. 5. Testing field for prestressed geotechnical (Rotar 2009)

It can be concluded that safety culture can be considered both a driver as well as a barrier to innovation in the construction field: it pushes further R&D activities in specific fields, but, typically, it also requires time before new, improved products and services can actually be implemented in practice.

There are, however, drivers leading to good practices in the implementation of innovations within the construction sector that could be taken as exemplary, especially in the field of non-technological innovations.

Procurement, design and construction of 12,9 km long Confederation Bridge, the longest bridge over ice-covered water, linking Prince Edward Island with the continent in NE Canada (Northhumberland Strait) (Figs. 6 and 7), for example, included several innovative features.

First, organizational innovation was introduced into the procurement process by the client (government). Public Private Partnership was established as the procurement model, by which the private partner was obliged to maintain the bridge for 35 years, and thus, he was highly motivated to construct a durable structure in order to decrease maintenance and refurbishment costs during the operation stage. This procurement model may be treated as a nontechnological innovation that results in better quality of the provided service due to enhanced performance of the facility in its operation stage, as well as in optimized total costs (that include construction, maintenance and operation costs).

During the design stage, the following innovative features were introduced in response to extreme conditions to which the bridge was exposed, as well as size and complexity of the structure:

- innovative design of pier cross-section (required due to extremely high mechanical loads due to ice-crushing and related vibrations, extreme tidal regime, as well as due to environmental concerns regarding sea life) (Fig. 7);
- required design service life of 100 years and probability of failure of 3.17×10^{-5} for the structure.

The increased level of reliability reflected the importance of the bridge as the principal transportation link to Prince Edward Island that placed extremely harsh requirements on the design of the bridge and the materials to be built in the structure. In particular, these requirements dictated the following technological innovations:

- the use of concrete with extremely high performance and
- installation of the instrumentation for measuring the ice forces and observing ice behaviour against piers (Brown 2006), to mention the most important ones.

In terms of materials, ultra-high performance of the concrete, built in the structure, was related to freeze-thaw resistance, compressive strength and abrasion resistance.

From the presented case study, it can be derived that client played an extremely important role in ensuring the quality of the structure, by encouraging the use of innovative, high performance materials and systems, as well as enabling innovative contractual relationships in project initiation stage that motivated the stakeholders to ensure high performance of the structure as a whole while maintaining maintenance costs within planned budget.

Fig. 6. Confederation bridge: airview (www.confederationbridge.com)

Fig. 7: Innovative design of bridge piers (www.confederationbridge.com)

6. Discussion and conclusions

Construction sector consists of enterprises of varying nature, size and type of work they execute. Contracting companies that carry out the construction works range from micro- to mid-size and large enterprises, out of which some compete on the international level. Certain companies are niche-oriented and therefore highly specialized (e.g. refurbishment of residential buildings; erection of steel structures), and some are taking over the role of a general contractor, working either in single (e.g. residential construction) or multiple markets (e.g. industrial buildings and infrastructure construction).

Due to the fragmentation of the industry, the construction sector is often perceived as low technology and labour intensive, where innovations are rare. A systematic view of the sector activities, however, shows that various innovations are implemented in construction activities, after barriers of technical and legislative nature, that the company is faced with, are surpassed.

Both technological, as well as nontechnological innovations are encountered in construction; the latter can appear also on inter-organisational level. In principle, innovations can be implemented at all levels, within the enterprise, a single organizational unit within the enterprise, as well as in cases when the enterprises form an alliance, such as, as discussed in this paper, a public-private partnership.

Efficient innovation management in construction leads to more efficient use of available resources, lower level of energy embedded in the structure, a well as to better managed work processes. As such, it is vital for further development of this particular industry.

The topic of fostering innovations within construction sector should, therefore, receive special attention, as its systematic fostering from governmental as well as non-governmental side can have an extremely beneficial influence upon the sector performance, regardless of the existing level of activities on the demand side.

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