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an integrated model

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INNOVATION MANAGEMENT IN CONSTRUCTION COMPANIES
- AN INTEGRATED MODEL

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ABSTRACT

Today, construction companies face many challenges due to the changed technical, economic and social conditions inside and outside the sector. However, if these challenges are regarded as a chance to gain advantages in competition, they require changes in the services offered as well as in the construction methods and the organization within the companies. As soon as such a change is an economically successful novelty for the company, it can be considered to be an innovation. This paper presents the results of a research project, that consisted of two detailed case studies in two medium-sized Swiss contractors. It focuses on the innovation processes in one of the examined companies. Based on four dimensions of investigation the essential tasks in these processes were found out and assigned to different phases. At the same time the main influences within the phases and their effects on the innovation process itself were determined. In all this the research always took into account the strategic orientation, the culture and the organizational structure of the company. Finally, a set of means and tools for intentionally initiating and efficiently creating innovation processes in the company was generated. Underlying an integrated model of innovation management the correlation between different aspects influencing the innovation processes in the company could be pointed out exactly. Therefore, appropriate means and tools to improve the innovation activity of the company could be developed successfully. It is concluded that the encouragement of innovation in the construction industry requires more case studies with an integrated view.

KEYWORDS:
Innovation; innovation management; construction companies; case studies

INTRODUCTION

From the late 1980s, the socio-economic conditions for the Swiss construction industry have been changing in such a way that with its structural shape it can only to a certain extent face the new challenges. As in many other countries the changed needs of clients, the continuously bad situation of the public budget, the economic globalisation and the raised environmental demands can be identified as the main reasons for the crisis and at the same time as challenges for a change (Seaden, 1996). Facing these challenges the structural problems of the construction industry become obvious, for what is needed are efficient solutions for high quality buildings in regard to the whole life-cycle of the buildings. It is particularly the cutting of surplus capacities carried out by construction companies and their competition only by decreasing prices that are no longer sufficient measures for economic success in the long run. Apart from this, it is necessary to bring about changes in services and construction technologies as well as organizational structures of the companies, which differ from the competition and orientate towards the needs of the market. If these changes are new and create economic success for a particular company, they can be called innovations. However, in order to innovate successfully, it is necessary to become aware of adaptation problems in time, which result from technical, economic and social changes, and to find solutions for them by creating efficient innovation processes. A construction company's ability to compete in the future and its profit situation to a great extent depend on this.
How do these innovation processes have to be designed, so that their results lead to an advantage in competition? Answering this question primarily means solving an organizational problem, which is widely determined by the specific situation of the company. Therefore, for a successful organization of innovation processes it is recommended to view a company in its entirety and with its peculiarities, being guided by the following questions:

1. **Which innovations does the market require and is it possible to introduce them with the services and technologies at one’s disposal and with the present structures of the company?** (characteristics of the sector and characteristics of the market)
2. **Which actions have to be taken, so that the innovations will be successful on the market?** (company strategy)
3. **Are the norms and values respected within the company suitable for introducing the desired innovations?** (company culture)
4. **Which tasks have to be fulfilled, in order to introduce the innovations and how do these tasks have to be divided and coordinated within the company?** (organizational structure)

In the following section the results of a research project, which investigated two medium-sized Swiss construction contractors with the help of the above mentioned questions, will be presented. The innovation processes going on in these companies were examined with regards to the specific conditions in each company. The results of the research showed that only an integrated view considering these specific conditions and aspects of the company strategy, the company culture and the organizational structure identifies the weak and the strong points within the innovation activities of a construction company and allows the development of effective means to reduce the weak and foster the strong points. This paper presents the dependence on the important aspects influencing the innovation processes of one of the contractor. Furthermore, some of the means and tools that were developed to improve the innovation processes and foster innovation within this company are described.

**PROJECT AIMS AND RESEARCH METHOD**

The one year research project consisted of two phases. In the first phase the innovation processes of the company was analysed, in order to find sufficient answers to the initial questions, the innovation processes were regarded under four dimensions. This division determined the form of the data gathering. The second phase was aimed at developing an appropriate set of means and tools to support the innovation activities of the company. Because of its integral approach the research project is methodologically to be classified as case study.

**Dimensions of investigation**

Innovations are not ends in themselves. They are meant to achieve business aims in a new way. The part they play in a company, finally depends on their importance for achieving the set aims. However, it is first of all necessary to know one's aims and to define the ways to reach them. If innovations shall be supported, their significance for the company has to be evident from the system of aims and strategies (Pries and Janszen, 1995). Here the existing system of norms and values in the company serves as a framework. For innovations can only be successfully introduced and supported by organization, if the company culture is open to innovation. The communication, the preparedness to take risks, the willingness to co-operate, the system of incentives and the freedom to innovate for the staff members are cultural aspects that have an influence on the company’s ability to innovate (Tatum, 1987). The **company-related dimension** examines the defined system of aims and strategies as well as the system of norms and values conveyed by the top management with regards to its orientation towards the support of innovations. Furthermore, it was analysed whether these ideal principles are really performed in the company.
Each new and economic successful idea generated and realized within a company can be regarded as an innovation. These ideas refer to different contents. It can be a new service offered by the company (service innovation) or new construction methods the company uses to provide their services (process innovation) or even the organizational structures of the company (organization innovation) (Vahs and Burmester, 1999). Moreover, innovations are characterized by the degree of their novelty. It ranges from small (incremental) improvements to fundamental (radical) changes (Slaughter, 1998). The relation to a specific project typical for construction companies marks another distinctive feature of innovations (Girmscheid and Hartmann; 1999). Under the object-related dimension the features of innovations in the company and their intensity were recorded.

Innovation processes go through different phases, which can generally be divided into the following phases: stimulation of the idea, generating the idea, assessment of the idea and realization of the idea. There are various requirements to the organizational form of each phase, and the phases are supported by different measures (Thom, 1992). Several factors can have a beneficial or obstructive effect on the phases. The tasks that go with each phase and their organizational embedding in the business processes and structures were specified under the phase-related dimension.

In most cases staff members belonging to different functional and hierarchic areas take part in innovation processes. They fulfil different tasks within the innovation process and therefore ideally have special abilities, too. What is needed are staff members who are particularly creative, or staff members who make decisions and put them through as well as staff members who have the professional know-how (Hauschildt and Gemünden, 1999). Under the person-related dimension the ability and willingness of the staff members to innovate were examined.

With these four dimensions an integrated model of innovation management in construction companies can be built up (fig. 1). It provided the framework for both the investigation and the conceptual phase.

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**Figure 1:** The integrated model of innovation management in construction companies
Data gathering
In order to get relevant information, an approach was chosen which applies various methods of data gathering. The intention of this was to see to it that some aspects that are insufficiently taken into account by one method will be included into the examination by applying another method. At the same time choosing a method of data gathering the results of the previous step were taken into consideration.

A group discussion with participants from the middle management (project managers) of the company took place, but before that every participant had to put down in writing the process of one innovation in his area of work and to point out the conditions for innovation in his particular area of work. These reports were summed up to single statements, which were afterwards discussed in group. The results of the discussion were categorized and assigned to the four different dimensions. The group discussion was meant to give a first insight into innovative action and its preconditions in the company.

The analysis of documents one the one hand aimed at finding out the norms and values that are desired for and required by the top management of the company and one the other hand at discovering the set aims and how this aims should be realized. At this point, the centre of attention was finding out what part innovations play within the company culture as well as their significance within the company strategy. At the same time, it was tested if the desired norms and values and the aims and strategies are compatible. The analysed documents were the company's newspaper, the company's philosophy, the general company strategy and the strategies of the departments. All documents were examined for statements that include elements of a company culture supporting innovations and therefore can be regarded as elements of an innovation strategy. These statements were again summed up in aspects, assigned to the four dimensions and related to each other.

The interviews with staff members were intended to give a detailed description of the innovation processes going on in the company, to verify if the relations presumed in the group discussion are real and to find out the effects of the norms and values desired by the top management. In view of these aims the survey took the different hierarchies and business areas into consideration. To make sure that the results of the interviews have a sufficient foundation, 16 single interviews in two rounds were carried out. The analysis of the interviews followed the theory of the dimensions. As it was the case in the group discussions, for every dimension the statements were summarized in aspects.

THE RESULTS OF THE INVESTIGATION
At the beginning some important features of the construction company have to be given, in order to provide a background, that makes it possible to understand the research findings below. The analysed company is a contractor with approximately 1000 employees. Its offered work encloses building construction, construction of tunnels, road construction, bridge construction, maintenance of buildings and special services like deep drilling and demolition work. The contractor's organization is subdivided in technical and regional business units. One of the business units offers total services for buildings, whereas the others have mainly operated in the classical manner (starting their work when the planning is made) up to the present. In the following the results of the data gathering are presented. However, only the results of the study in one company are taken into account, in order to be able to give a sufficient insight into the correlation of the relevant aspects in the different dimensions of the study.

Company-related dimension
The status of innovations in a company is above all expressed in the ideas that the top management (senior managers) has on norms and values as well as on aims and strategies.

In the analysed company innovations play an important part in successfully responding to changes in the company’s environment. These changed external conditions are regarded as substantial for the
necessity and the importance of innovating. The chief aim of innovations is to contribute to meeting the needs of the clients, providing for the quality of the services offered and gaining advantages in competition. Innovations are considered as a task that every staff member has to fulfil in an active and extensive way, while the quality and professionalism of the management on all levels is viewed as a precondition for it. One of the means intended to encourage the innovating abilities of staff members from all the different hierarchical levels within the company is an active policy of improving the staff’s qualification. Delegating responsibility is the main intention of the top management. Letting staff members act autonomously and giving them demanding tasks shall contribute to their motivation. Thus an employee shall have freedom to find innovative solutions and he or she shall become more willing to innovate.

Changes in the environment of a company and above all changes in the demands of the clients are responded to by adapting the company’s services and the corresponding markets. The reaction takes place when changes in the environment have occurred or are still occurring. Being open to changes respectively adapting to new conditions is the main component of the innovation strategy. Another component of the innovative strategy is the ability to develop technical aids. This means actively looking for technical solutions to problems and implementing them. The precondition for this is a reasonable balance between the efforts that have to be made and the usefulness of the new solution. The knowledge that is available in the company, e.g. the knowledge on how to solve technical and economic problems and which means and methods have to be used for this, shall be used more efficiently for the company as a whole. An active internal exchange of information is the way intended to achieve this. Using the available knowledge is the third component of the innovative strategy.

Novelties can affect the range of services offered, the execution of work or the organization of the company. Here it has to be possible to adapt all services of the different fields of activity within the company with respect to their extent (single service or total service) according to the requirements of the market. Typical for the company under examination are small improvements. The ability to constantly bring about improvements in all fields (technical and organizational) is a substantial value of the company and it contributes decisively to the success of the company.

After the description of the ideas that the management has on the importance of innovations for the company a closer look is taken on the norms and values that are respected in the company.

The formal communication between the business units of the company at its headquarter can be regarded as unproblematic. The fact that their work is concentrated on projects and that the departments are situated closely to each other contributes to an active exchange of information, including informal information, which is further encouraged by short distances for passing on information and the existence of places open to the public (e.g. cafeteria). However, formal and informal communication between business units located in different regions is restricted to a minimum. A common type of formal communication within the business units is the meeting of the construction site management, which takes place every week and gives the opportunity to exchange new ideas or to discuss problems. If the novelty has a concrete form, such as a new machine, the idea can easily be passed on. As soon as the new idea is connected with practical action, it is more difficult to pass it on only by communicating. This is why many employees think that a sufficient number of new ideas is created at a construction site, but that there is an insufficient exchange of these ideas among the people working on the construction sites. If the exchange of ideas does not work properly within one business unit, it will hardly ever be practised within the company. With respect to the component of the innovative strategy that is called “using the available knowledge”, it can be detected that the exchange of information and knowledge, which the management thinks is active, does not work properly.

The fact that single business units work autonomously to a certain extent prevents a co-operation of business units in carrying out new services. As one business unit has to take the risk, other units are
not willing to share it. This leads to the fact that services are sometimes not carried out using the company's own capacities. In this case the chance to use the company's potential as an advantage in competition is not taken.

In all the phases of one project there is always not enough time to look for new ideas and to realize them. This restriction is partly due to external influences as for example when only a short period of time is given for the making of a large-scale offer or when there is only a short period of time between the contract award and the beginning of the construction work or when detailed plans are made too late.

**Object-related dimension**

Taking the cultural and strategic aspect of innovation into account, the types of the introduced innovations in the company become understandable.

In most cases new ideas will belong to the process innovations. Service innovations and changes in organization are rare. The flexibility to adapt, which could also be identified as a component of the innovative strategy, marks the innovative action in the company. A disadvantage of this strategy is that there is the danger of not responding fast enough to certain developments on the market or even of not responding to them at all. Therefore, the company may lose the chance of getting long-term advantages in competition. There is one business unit which can be regarded as an exception with respect to the innovative activity in the company, that is the business unit offering total services. This unit realizes innovative ideas in every project, as its usual way of handling projects is to compete in the field of services.

The prevailing response to changed conditions on the market leads to the fact that innovations are normally created in connection with projects. Service innovations arise from acquiring orders, whereas process innovations appear while offering the service or after the contract award. Designing variants makes it possible to innovate at the phase of tender. Yet, the above mentioned lack of time restricts this possibility. What is up to now only insufficiently used beyond the frame of one project is the practical knowledge acquired from experience, above all by finding technical solutions in single projects. The reason for this is the lack of time and communication that has been mentioned earlier.

The relation to a specific project has an influence on the degree of novelty, too. The major part of the innovative activity in the company brings about small improvements (incremental innovations) and this corresponds with the ideas of the top management. The reason for the small degree of novelty is to be seen in the restricted framework of time and finances for one specific project. Often decisions have to be taken within extremely short periods of time and there is no time for clearing up details. Because innovations are seldom realized independent of projects, there are not many possibilities to realize great changes (radical innovations).

Furthermore, the possibilities to realize novelties can differ, which depends on the form of the service. New and specific fields of service (e.g. maintenance) offer a wider range of possibilities than traditional services (e.g. building constructions), because the contract specifications for these services contain fewer details due to the lack of experience on the side of the planning institutions and because the technical developments of the suppliers do not yet fulfil the functional requirements. However, during the last few years there has been an increasing demand for total services in the traditional business units, which makes innovative solutions with a higher degree of novelty possible in this field, too.

**Phase-related dimension**

The type of innovation also has an effect on the course and the organization of innovation processes. Most ideas come up, as there are problems in the preliminary work for actual construction work and in the construction operation of one specific project. Price pressures on the project, which require new ideas, in order to be able to finish the construction work profitably, can be regarded as one of the main problems. Besides, new possibilities are taken from specialist journals, from other staff members, at
trade fairs, from competitors and suppliers. Another form of stimulation is the acquiring of contracts, which has been mentioned before. In a few cases novelties are stimulated by free capacities of the company. This last point shows that short-term thinking which is restricted to the current project is problematical. The company will try to find new services to offer only if there is no longer a demand for the services that it has offered up to now. At this point in time going into new fields of services might require a greater effort than it would have had at an earlier time.

Persons coming from all stages of the site and project management (foreman, site manager, project manager) can act as the supplier of new ideas. It is the project team that develops the ideas. In most cases the team members are looking for new ideas on their own and later discuss it in the group. If the project team cannot find a solution, internal specialists will be consulted. If this is not successful, the next steps will be searching for solutions on the market or trying to find a me-too-product. This approach is typical for process innovations. The process of finding service innovations does not go along such exact lines. One of the reasons for this is that the range of services demanded on the market varies with its requirements from the services the business units used to offer. This results in an uncertainty with regards to the competencies and the assessment of the risk as well as in a lack of preparedness to co-operate.

While decisions on new solutions for problems are taken in the team, in order to avoid mistakes, decisions on small improvements are taken within the business unit or for one project. If the novelties require a considerable amount of investments, the heads of the business units will prepare the decision which is then taken by the top management. Of prime importance for taking a decision in favour of a novelty that will change the project is the visible advantage it brings about for the client. If the new solution to a problem concerns the construction methods in the project, its realization will in most cases be uncomplicated.

Person-related dimension
It is regarded as important for all phases of the innovation processes that the staff member is supported by the superior. The superior has to be behind the idea, he has to justify it and utter his support clearly. Some of the interviewed staff members said that their superiors lack this ability and criticized it, because those employees that are willing to innovate may loose their motivation.

Although it is possible for staff members to try new ideas in the company, the willingness to do so is not rewarded or supported. There are no clearly visible incentives for staff members to find innovative solutions. On the one hand, the existing system of incentives (premium bonuses) is not sufficiently taken advantage of, on the other hand different staff members react in a different way to incentives. Some employees are already stimulated to find innovative solutions by their success at work and the possibility to introduce novelties, but they often do not have enough time or they lack the above mentioned specific support and appreciation of their superior.

THE RESULTS OF THE CONCEPTUAL WORK
In the second phase of the research project appropriate means and tools were developed in cooperation with the middle management and combined to a conception, that considers the relevant aspects of the contractor's innovation processes found in the investigation phase. The guiding questions were:

1. Which means and tools are appropriate to improve the beneficial aspects of the ongoing innovation processes?
2. Which means and tools are appropriate to reduce the obstructive aspects of the ongoing innovation processes?

The Innovation Centre
The Innovation Centre was developed to be a functional part of an existing business unit, that already works as a service unit within the company providing engineering solutions for problems on the
construction site. The central task of the Innovation Centre is to create new ideas either on the construction project, the business unit or the company level. On the construction project level special solutions for the phase of tender and the phase of execution are developed. On the business unit level problems of the process engineering overlapping projects are taken up and solved. On the company level projects aiming at developing new business activities are supported technically and methodically. These services can be used within the company to complete absent know-how in the project team and to technically assist the project team. Furthermore, the business units are able to give a development order to the Innovation Centre. The Innovation Centre can also initiate and carry out innovation projects in which staff members of other business units are involved. In addition, the Innovation Centre coordinates the innovation activities within the company. Suggestions for improvements, realized ideas and problems of all employees are received. Innovation projects will be managed and the results of the projects will be documented centrally, so that all business units have an easy access to the information. Moreover, all business units will regularly be provided with information about finished projects with innovative ideas. So, the Innovation Centre is a central and permanent know-how centre, being available for the whole company. New ideas will be created, collected and spread systematically within the company.

The Task Force
The Task Force is a temporary project group. It is set up, if orders are requested that require services that are either non existing or are existing incompletely on the business unit level. Thus, the members of the project group are able to belong to all business units according to the services, that should be integrated. Staff members from all hierarchic levels can suggest the initiation of the Task Force. But only the top management on the business unit or company level decides about the formation. If necessary, the Task Force is formed as soon as possible with an accurately defined project management and a concrete order. After working out a solution the project group will be disbanded. With the Task Force a tool for the top management is provided, that allows a quick response to changes of the market. New fields of activity can be systematically opened up and specific problems and needs of clients can be solved satisfactorily. Moreover, total service packages can be offered, which in the past were not efficient due to the expenditure of coordination. Another impact is that the company is in a position to present itself as competent, flexible and innovative on the market.

The Innovation Pensioners
The Innovation Pensioners are elderly, but experienced staff members technically consulting projects with innovation potential. Moreover, they will train new staff members and transmit their knowledge to the next generation of engineers. On one hand reducing the daily routine activities release the Innovation Pensioner from different stress elements, on the other hand their work gets an important appreciation with positive effects on their motivation. Projects, Innovation Pensioners can be involved in, could be initiated by the Innovation Centre or the Task Force. It is also possible that they take part in normal construction projects. In this case, Innovation Pensioners relieve the project team of work and increase the chance for a successful and innovative project.

In addition, further means and tools were developed, which shall be mentioned shortly. The Innovation Groups can be formed by staff members of the single business unit. All staff members on the lower hierarchy levels get the opportunity to permanently and deliberately think about improvements at their workplace. The Project Checkpoint is a tool that checks construction projects at different times for the possibility to innovate particularly considering the peculiarity of the single project. It will be integrated in the Quality Management System. The Information System was developed to communicate innovative solutions and ideas of the business units respectively the construction sites within the whole company. Ways of communication are for example visits of construction sites, brochures, information meetings and news groups on the intranet. Finally, a System of Incentives was worked out in co-operation with the top, middle and lower management.
CONCLUSION

The processes of innovation described in this paper are strongly related to the specific conditions of the examined contractor which can be characterized by internal and external factors. If these features are set in relation to aspects of the company strategy, the company culture and the organizational structure, a pattern of innovation can be discerned that allows an appropriate management of innovation.

In medium-sized contractors the implementation of process innovations does not seem to be problematic, because most of the developments originate from the supply industry. Although the introduction of a new construction equipment or material is well organized, it does not bring about a great advantage in competition. However, the opportunity to become more competitive increases with the knowledge established in the company so that it cannot be easily copied and will be used systematically for innovative solutions in the construction projects. Two ways are possible. First, the traditional services can be extended with additional knowledge, in order to meet the market demands for total services and to increase the range of innovative solutions. The prerequisite for this is to overcome the barriers of co-operation between autonomous business units. Second, new ideas produced by all staff members should not be restricted to single projects but be learned by the company and applied to further projects. Before doing this the ideas have to be created. However, the lack of time often prevents the members of project teams from thinking of new ideas. Therefore, solutions that already exist are used. As external restrictions are mostly responsible for this, either a better project organization or a relief of the project team are practicable measures. Furthermore, the management style of the superiors is essential for the motivation of the employees to be innovative. The request for innovative activities alone is not sufficient. Although the delegation of responsibility creates freedom for innovative behaviour, the active support by the top management and a discernable system of incentives is necessary. The realization of these approaches within the organizational structure of a medium-sized contractor could be shown.

To sum up, it is necessary to take an integrated view of the innovation processes within construction companies, in order to improve the companies' ability to innovate. That means, more detailed case studies have to be carried out regarding the specific features of the construction companies, in order to understand how these companies innovate and to find out which are the common and correlated aspects influencing the innovation processes. Thus, in a further phase of research the results of the second case study will be compared with the first one to find out whether both patterns of innovation are identical and to put the model of innovation management in construction companies in concrete form.

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