The innovation potential of integrated services and its utilisation through co-operation

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Keywords

Integrated marketing, Competitive advantage, Innovation, Construction industry

Abstract

In the last few years an increasing demand for integrated services could be recognised on the construction market. For construction firms this means that there is a wider scope for achieving advantages in competition. Based on a research project on the innovation behaviour of two Swiss contractors this paper presents the innovation potential of integrated services and the advantages and disadvantages of the present organizational structure of medium-sized contractors with respect to the usage of this potential. Moreover, possibilities for construction firms to build up and benefit from internal and external co-operation and to generate innovative constructional solutions are discussed. It is concluded that an innovative construction industry requires the ability of construction firms to co-operate.

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Introduction

Construction firms are nowadays more and more faced with changes of the basic conditions of their business (Pries and Janszen, 1995). As a result of globalised markets competitive national economies must efficiently construct industrial and infrastructural facilities, a fact that is even more intensified by an increasing number of privatisations of former state-owned enterprises. Clients ask for more and more constructional solutions that pay attention to the whole building life cycle. The client is concerned about yields and values and is looking for solutions that will guarantee the lowest possible expenses for maintenance and operation as well as high values for a certain time. He wants to get buildings that can be easily, flexibly and quickly adapted to possible changes in utilisation (Slaughter, 2001). As a consequence, buildings are more and more characterised only by their functions and the requirements resulting from them. Construction firms will have to find out how to meet these requirements and thereby find new ways of extending their service offers and organising their work. The single service necessary for designing, producing and operating a building can be brought together and combined so that they result in an optimal solution for the client's demands. Moreover, such integrated services will increase the incentive to realise new or improved design principles, construction materials and methods as well as building equipment, because of their contribution to achieving an optimal constructional solution.

However, the construction industry is predominately characterised by numerous different interest groups and especially by the separation of design and production (Winch, 1998). The sequential procedure of construction projects leads to the fact that goals of project participants differ and only services of the single level of value added can reach the optimum, but the results of the total constructional solution remain suboptimal (Barlow, 2000). In addition, the competence and incentive that is necessary to develop new technical solutions, to implement these solutions into buildings and to co-ordinate the implementation is mostly lacking. Consequently, construction is still associated with a traditional and slowly changing industry (Atkin, 1999).

This paper is reflecting the innovation potential of integrated services and organizational solutions that aim at combining the competences necessary to use this potential. It is based on research project, which was conducted together with two Swiss contractors. The project consisted of two parts. In the first one the innovation processes that take

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place within the firms were examined and the factors that influence these processes were determined. The second part aimed at developing and implementing tools for promoting innovations in these two firms. For data gathering group discussions with the upper and middle management, semi-structured interviews on all hierarchical levels of management and analyses of strategic documents were carried out. For working out measures fostering innovation project groups were established, which developed several tools during workshops.

In the following sections the current possibilities of the two medium-sized contractors to innovate are evaluated. The innovation potential of integrated services too is highlighted and illustrated with different examples from literature. The organizational qualifications of the examined contractors to use this potential are discussed and possible organizational solutions of co-operation are shown enabling these firms to generate innovative constructional solutions.

Possibilities for contractors to innovate

Up till now a major characteristic of the contractors under examination is the fact that they offer different production services (like carcass or pavement work) within different lines of business (like building construction or road construction). Usually they take part in a construction project only at a point of time when the design is nearly finished. This means that they have to make the production process adapt to the structural and local conditions of the building. An efficient solution to the problem of adaptation is combining known and/or new production methods. Using new methods can mainly be equated to the introduction of new developed equipment. This introduction process is well organized in the firms and does not have special requirements apart from the financial resources needed, because in most cases it is the introduction of almost applicable solutions and continuously made improvements. As the new developments of the suppliers of construction equipment are available for every contractor, too, the advantage in competition that can be gained here is relatively small. It increases, if the knowledge acquired from former projects is used to mutually adapt the structure of the building and the construction methods in a way that an entirely optimised construction solution is obtained. However, these alternative tenders often include the following problems.

- Principally the client has to accept an alternative tender of the contractor, but not every client wants to get suggestions of possibly better solutions.
- It has to be convincingly proved that the alternative solution has visible advantages in comparison to the first plan, but if the alternative solution is convincing and worked out in detail, there is also the danger that the client will look for another firm that will realise the idea for less payment. Furthermore, especially with ideas that are new for the firm it is difficult to prove the advantages of a solution (references).
- The designer of the specification may fear a loss of image in the eyes of the client as a result of the contractor's alternative tender, and may reject the alternative tender.
- In most cases the actual tender has to be further developed, so that an additional offer can only be provided with additional expenditures of time or staff. Often good ideas cannot be realised, because the time that is given for working out an offer is too short and the staff needed for this is not available.
- With larger projects parts of the execution are passed on to subcontractors. This leads to the fact that many subsystems of the facility and the construction process have to be co-ordinated, which in turn leads to higher expenditures on co-ordination and makes it more difficult to reach the optimum for the whole building.

The problems with alternative tenders in both firms clearly showed that without an early consideration of production issues in construction projects an overall optimised constructional solution is hardly to achieve and the potential of contractors to innovate is restricted. Integrated services open up a wider range of possibilities, as they allow combining the knowledge necessary for solving the entire constructional task at earlier stages of the construction project. Before discussing organizational forms of connecting design and production services the innovation potential of integrated services is highlighted.

The innovation potential of integrated services

Characterisation of integrated services

In simplified terms a constructional task can be regarded as a transfer process which translates the client's demands into qualitative and economic characteristics of a building. The transfer process is successful, if in the view of the client an optimal constructional solution can be found. An optimal constructional solution is achieved, when

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materials, components and building equipments applied constitute a structural and architectural combination that meets the functional and qualitative requirements made on the building for a certain period of time. If these requirements are met within the framework of a defined amount of investments and a set construction period and if they can be guaranteed within the defined period of utilisation, while the expenses for maintenance and operation remain moderate, the constructional solution can be regarded as economically optimal too. Such an optimal constructional solution may be provided by integrated services, which connect the single services or levels of value added of designing, producing and operating a building. In doing so, the interdependencies between the single components of the building as well as the influences of the design, production and operation processes on the components and the building on the whole can be recognised at an early point in time and can be formed deliberately. It is assumed that the view of the building as a system in its total life cycle also allows more innovative solutions, as starting points for innovations can be comprehensively detected, impacts of innovations on the building and the construction process can be determined in sufficient time and conditions of realising innovations can be appropriately considered. In the following the relation between service integration and possibilities for innovation is pointed out and illustrated with examples from literature. First, the innovation potentials connected with design and production services are separately depicted. Second, the additional potential resulting from a combined consideration of both kinds of services is presented.

Innovation and design services

The innovation potential related to design services can be obtained from a system-orientated view of buildings, which represent the primary design objects. Portrayed in simplified terms a building is made of different components, which are structurally combined with each other. They form the functional and qualitative characteristics (e.g. usable space, energy efficiency) of the building, while the characteristics of each component result from the coaction of different construction materials. Based on that, two main starting points for influencing the characteristics of a building by innovative solutions can be detected.

- The development and/or usage of a new or improved construction material. For example, by combining special aggregates (i.e. fly ash), binders, thermal resistant materials and additives a concrete with better fire safety can be realised (Wetzig, 1999).
- The development and/or usage of an engineering principle that makes use of the existing characteristics of construction materials by combining components in a new way. Segmental bridges with external prestressing can serve as an example for finding a new structural design while applying known construction material, such as concrete and prestressing steel. As the segmental superstructure is prefabricated and stressed together externally, an economical and high quality facility can be achieved (Girmscheid and Hartmann, 1999).

Both innovation streams can be interrelated, if the changed characteristics of a new or improved construction material lead to new engineering principles. For example, the development of a waterproofing membrane for shotcrete coatings, applicated by spraying, in tunnel construction brings about a structural connection between the formerly separated internal and external arch formwork and the sealing. Instead of the two-leaf arch formwork there is just a one-leaf arch framework, which results in a considerable reduction of material requirements (Amberg, 1998).

Innovation and production services

Regarding the innovation potential related to production services one can find starting-points for innovations in the structure of production processes. Production processes can be defined as the temporal and spatial organisation of activities necessary to erect a building. These activities possess the function of changing material, energy and information, which is carried out by the construction equipment and its operator. For changing a material's structure, shape, position etc. the construction equipment uses a specific method based on a recognised law of nature. With this view three main starting-points for improving the characteristics of the production process (e.g. efficiency, operational safety) can be found.

- The development and/or usage of a new construction equipment which substitutes a function of human work. Computer-controlled shotcrete robots can serve as an example for this. Shotcrete was usually applied by hand-operated nozzles. The development of manipulators aimed at substituting the operator's function of guiding the nozzle to improve the work safety and the performance. The next step includes the substitution of the operator's function of controlling the application process. Fully automated shotcrete robots ensure

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the quality of the thickness, compactness and evenness of the layers (Girmscheid and Moser, 2001).
- The development and/or usage of a new method of changing the construction material. While most tunnel boring machines overcome the rock's resistance to pressure, some tunnel boring machines make use of the far lower tensile strength of the rock, which allows a more efficient excavation of different tunnel cross sections (Baumann and Zischinsky, 1994).
- The development and/or usage of a new way of organising the production process. For example, by using a suspended platform for drill and blast heading the supply and disposal of the heading can be executed at the same time with the work on the tunnel base. Thus, the efficiency of drill and blast headings can be extended (Gruber, 1997).

The examples indicate that all three streams can be interrelated, too. For instance, a new construction method which is normally followed by a new construction equipment and a new organisation principle can be triggered by the implementation of a new or improved construction equipment.

Innovation and the integration of design and production services

Up till now the innovation potential with regards to design and production service were shown separately, but if they are examined together, additional possibilities for innovation can be found. They emerge from the fact that the building and the production process are mutually dependent. The building is shaped by the production process which realised it. The impact on the innovation potential can be shown on the above-mentioned example of segmental bridges with external prestressing. In this case a new engineering principle led to the usage of new construction equipment and to a new organization of the construction process. The structural division of the superstructure into single segments was accompanied by the development of a new formwork system for the production of segments and new construction scaffolding for the segmental installation. At the same time the production process could be organized in a new way. The segments can be prefabricated and the superstructure can be erected parallel to the substructure. By this, the production period can be reduced and the quality of the superstructure can be increased considerably (Girmscheid and Hartmann, 1999). Considering the operation process, too, the innovation potential enlarges in the sense that the behaviour of the building and its components can be observed over the period of usage, conclusions on the building design can be drawn for future projects and specific further developments of single components can be made. Furthermore, systems that allow simple measures of maintenance can be developed deliberately. For example, in the segmental construction with external prestressing the prestressing of the tendons can be measured permanently and additional stressing may be carried out if necessary. It is also possible to change the tendons or to put in additional ones if the requirements have changed (Girmscheid and Hartmann, 1999).

It can be stated that the innovation potential of integrated services does not just consist of the single view of the building at its single life phases, but results from the early and specific consideration of the influences from the whole life cycle on the building system. This means considering a lot of different components and relations, the knowledge of which a firm normally has not completely in-house. Here co-operation provides the access to the innovation potential of integrated services.

Integrated services by co-operation

Characterisation of co-operation

Co-operation can be defined as the voluntary collaboration of persons or organisations with commonly agreed goals. They are strived for if the goals of the involved persons or organisations are reached more efficiently by a common than an individual fulfilment of tasks.

For structuring a co-operation different variables are available. First one is the intensity of co-operation, which describes to which extent the involved organisations possess rights of property and disposal regarding the resources necessary to fulfil the common task. With the co-operation intensity the transition between internal and external collaborations can be marked. The second one is the duration of the co-operation, which can vary from adhoc to strategic. A third variable is the number of organisations taking part in co-operation, which needs at least two organizational entities but can also include a comprehensive network of organisations. The last variable is the direction of co-operation, which mirrors the levels of value creation the involved organisations belong to and which can be horizontal, vertical or diagonal.

The specification of each variable depends on the context a co-operation emerges from and is subject of a firm's strategy. For example, construction firms offering services on one level of value added and operating in several market segments like the examined contractors are able to

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achieve integrated services trough internal and external, horizontal and vertical as well as strategic and adhoc co-operations. In the following it should be exemplified how the variables can be specified for these types of firms.

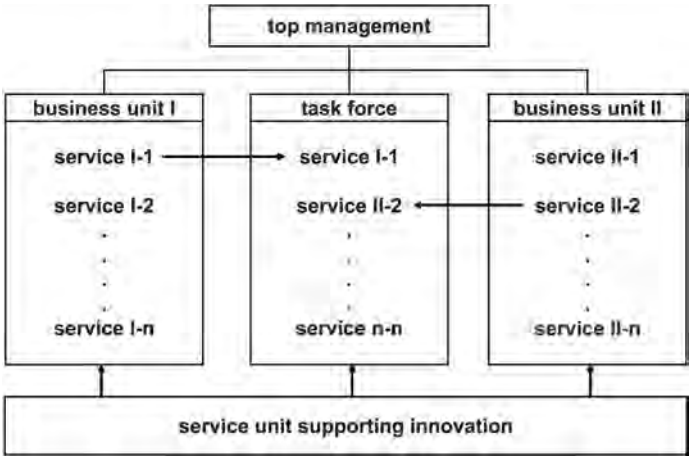
Internal co-operation

The first step on the road to integrated services is bringing together services for different subsystems of the building on one level of value added. Medium-sized contractors have the possibility for internal and horizontal co-operation, because they offer production work for different subsystems of buildings (for example foundation and carcass of a building) and for subsystems of different buildings (for example road construction and tunnelling). Thus, they can use for example the potential for new ways of organising the production process or implementing new construction equipment applicable in different segments of the market.

As the firms are structured into regional and specialised business units, which act autonomously, sometimes hindrances for co-operation appear. If the market requires integrated services for a construction work, for example the renovation of a road bridge, the necessary services can be executed by one firm, but the business unit responsible for bridge engineering and working on the total offer might not get an offer that corresponds with the market price from the business unit responsible for demolition work. There is the danger that the chance to benefit from an internal co-operation is wasted, because in working out an internal offer there is a lack of a feeling for competition. A further problem emerges, if new services which cannot be assigned to a business unit have to be carried out with future potential. For example, in one of the firms protection walls against noise represented a new service. They had to be erected along with the renovation of the mentioned bridge but no business unit felt responsible for it.

Here, an instrument is needed that can react quickly and beyond the limits of business units to such demands for integrated services. A task force established with regards to the requirements of the problem and consisting of persons from different business units, who are only temporarily working together, can take on this (Figure 1). The task force is formed within a very short time and has a defined project management. It gets a clear task, fulfils it and disbands after the work is done. It acts autonomously on the firm level, is directly responsible to the top management and thus is largely free from single interests of the business units. In this sense it can be regarded as a strategic instrument of the top management.

Figure 1 Internal co-operation through task force organisation



As with new service mostly unknown technical problems appear and the project team is often under a pressure of time, another organizational solution is required that supports internal co-operations. In one of the contractors under examination such instruments could be provided, which means, for example, enlarging an internal department for engineering services to an innovation centre. Fulfilling this new function, the department will on the level of construction projects develop alternative tenders during the tender phase and work out special solutions during the stage of production. Therefore, e.g. one member of the innovation centre will be included in the team of the construction project, in order to balance out a lack of know-how or contribute to the know-how of the team because of lacking capacities. Besides this project-related work the innovation centre can also tackle problems that go beyond the framework of projects and find solutions to them. Thus, innovations can be deliberately generated and developed in services that are of prime importance for the firm.

External co-operation

Along with internal co-operation medium-sized contractors nowadays often make use of external possibilities for co-operation, to combine services for production. This co-operation with other contractors is in most cases only temporary and related to one project, for example in order to be able to execute a large-scale project for which the capacities of one single firm are insufficient and the risks of which are unbearable for one firm alone. Working as a team (contractor combination) enables the firms to make capital-intensive investments like purchasing new large construction equipment like drilling jumbos for tunnelling. In these cases the introduction process usually goes on without problems, too, and options

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like renting the machines or selling them back to the producer make the decision for the investment easier.

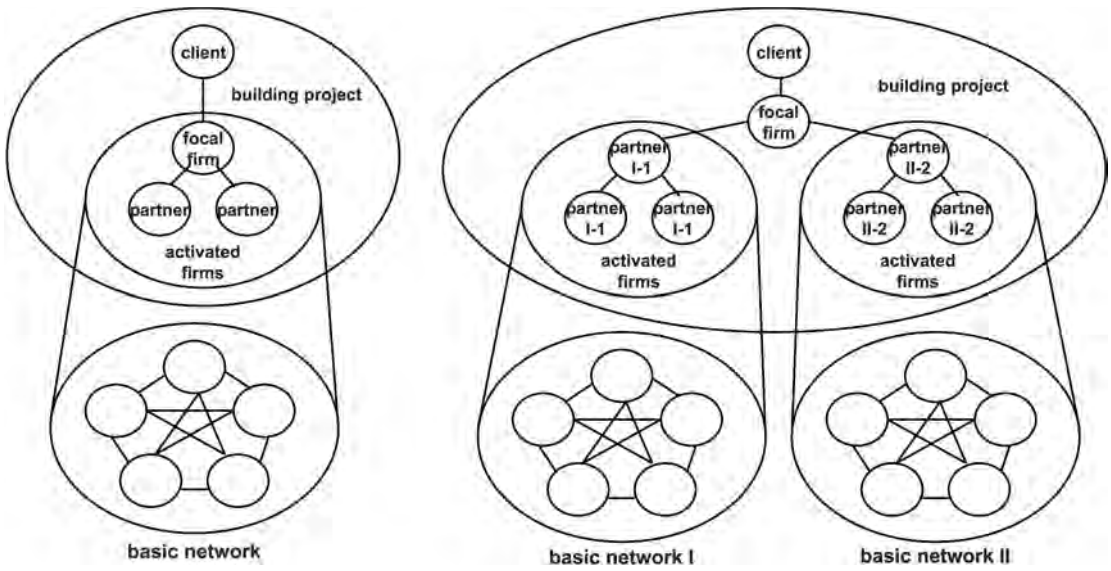
Nevertheless, the innovation potential is not exhausted by the co-operation on one level of value added. The range of services offered can be extended and the possibilities to innovate can be increased, if in a second step the services of different levels of value added for different subsystems of the building are combined. As the range of services offered by most of the contractors that have the size of the companies under examination does not include services except for the production of buildings, it is possible to fill this gap using external and vertical co-operation. As it is the case in internal co-operation, organizational solutions are needed with the help of which integrated services can be generated in an innovative way.

A suitable solution are strategic networks of firms, consisting of independent firms that are specialized in different levels of value added (Figure 2). Along with their production work medium-sized construction firms can take on the role of a focal firm or system integrator within the network. Fulfilling this function, they co-ordinate and integrate the complementary services of the participants of the network and activate them according to the specific requirements of the construction project. Depending on the size of the firm or of the construction project this integrative work may be restricted to subsystems of the building or include the whole constructed facility. That is to say, different activated firms, the services of which are in turn co-ordinated by a superordinated focal firm, can autonomously realise subsystems of the building. On the one hand this gives the freedom that is necessary for innovative partial solutions, while on the other hand the combination of partial solutions with each other, so that they form an optimal total solution, is guaranteed. Moreover, a long-term co-operative network that exists beyond the limits of one project allows the initiation of innovative projects aiming at a further development of the common range of services offered and thus gaining advantages in competition. This will make it possible to co-ordinate the developments of the levels of value added with each other and to generate extensive innovations in the above-mentioned sense.

Conclusion or what is additionally needed?

This paper tried to point out that optimal constructional solutions for the client can only be found, if the know-how of all levels of value added of a building is combined through integrated services. At the same time, by looking at the building as a system in its life cycle the innovation potential increases. By building up integrated services medium-sized contractors have the chance to make use of the innovation potential involved and to employ it as a means to gain advantages in competition. A prerequisite for this is the ability to co-operate, which has to be transferred into organizational solutions. Possible solutions for an approach from internal to external co-operation in two steps could be demonstrated. Modern Information Technology considerably supports the communication within these network

Figure 2 External co-operation through network organisation



organisations and thus helps to contribute to their successful work. However, there are two important aspects for the functioning of networks that arise from the mentioned fact that nowadays many different interest groups are at different times and just temporarily involved in the construction project.

First, there is not only a lack of possibilities for innovation, but also a lack of incentives to be innovative. The interests of the different groups are not always orientated on the aim on the whole, that is a building that optimally meets the demands of the client. Integrated services can provide the necessary orientation of single interests on one aim, as the inclusion of the requirements from the different life phases of the constructed facility takes place at a point in time, when they can be considered for the design of the total solution. If, for example, networks of designers and contractors offered operation services, too, these firms would have a greater incentive to look for innovate solutions as they aim at having low expenditures on maintenance and operation of the building and securing yield and stability of value. In order to make the requirements from the operation a part of the system of aims of the networks, the client may also let the companies participate in the savings or the exceeding costs from the operation by implementing for example a Bonus-Malus-System.

The second aspect is the development of trust in each other among the network members which is of much greater importance and an essential part of the ability to co-operate. All those who take part in the construction sector will have to change their ideas and views in this respect and to find a new cultural orientation. If a cultural change is a prerequisite for the successful work of organizational solutions like networks, at the same time a closer collaboration of firms within networks supports the development of trust. Consequently, establishing new organizational solutions has to be seen as a gradual process of finding common values and rules.

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