Report

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THE ABILITY OF CONTRACTORS TO CO-OPERATE - A KEY TO INNOVATIVE TOTAL SERVICES IN CONSTRUCTION

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ABSTRACT

In the last few years an increasing demand for total services could be recognized on the construction market. For construction companies this means that there is a wider scope for achieving advantages in competition, as the integrating view of the whole life cycle of a constructed facility makes it possible to find solutions that ideally match the clients needs and therefore differ from solutions suggested by competitors. Innovations contribute to achieving an optimal constructional solution by providing new systems and construction material as well as new construction methods and facility equipment. Up to now construction projects have been carried out stage-by-stage, optimising is limited to the service of the single levels of value added and the competence to integrate innovative developments into the constructed facility is lacking. This paper presents the innovative potential of total services and the advantages and disadvantages of the present organizational structure of medium-sized contractors with respect to using this potential. Moreover, different possibilities for the companies to build up and benefit from internal and external co-operation, in order to generate innovative total services, are discussed. It is concluded that the encouragement of innovation in construction requires the ability of construction companies to co-operate.

Keywords: total service, innovation, contractor, co-operation

INTRODUCTION

Construction companies are nowadays more and more faced with changes of the basic conditions of their business. As a result of the globalized 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. In these days clients more and more ask for solutions to their constructional problems that include to a great extend the whole life cycle of the constructed facility. 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 long time. He wants to get facilities that can be easily, flexibly and quickly adapted to possible changes in utilization, which might occur due to economics or technology. All this results in a rising demand for the quality of facilities, accompanied by a high pressure on the contractor with regards to expenses and time for the realization.
This is why constructed facilities are more and more only characterized by their functions and the requirements resulting from them. The companies will have to find out how to meet these requirements and here they can find new ways of extending their service offers and organizing their work. The single services necessary for the planning, the construction and the operation of a constructed facility can be brought together and combined so that they result in an optimal solution for the client’s demands. Thus, innovations contribute to achieving an optimal result by using new systems and construction materials as well as new construction methods and new facility equipment. Moreover, they represent new ideas that are for the first time successfully realized by a company and by this they offer chances for the company to gain advantages in competition. The incentive to innovate increases.

However, the construction industry today is still characterized by numerous different interest groups and especially by the separation of planning and execution. The sequential procedure of construction projects leads to the fact that only the services of the single level of value added reach the optimum, but the results of the total constructional solution remain suboptimal. In addition, the competence that is necessary to integrate innovative developments into the constructed facility and to coordinate this integration is lacking. The number of innovations within the construction industry is comparatively low.

This paper is reflecting organizational solutions that aim at combining the competence necessary to generate innovative total services. At the beginning the innovative potential for total services is deduced from different examples for innovation in literature. Two case studies, examining the ability of two medium-sized contractors to innovate, serve as a basis for evaluating the current organizational qualifications of contractors to make use of this innovative potential. In both case studies the processes of innovation that take place within the companies were examined and the factors that determine the process of innovation were worked out. For data gathering group discussions with the upper and middle management, semi-structured interviews on all levels of management and analyses of strategic documents were carried out. Based on these findings possible organizational starting-points for medium-sized contractors are shown enabling them to work out innovative total service offers.

THE CHARACTERIZATION OF TOTAL SERVICES

Total service offers connect the single services or levels of value added of planning, construction and operation of a constructed facility, in order to transfer the demands of the client with respect to the building to a total solution that is technically and economically optimal. A technically optimal total solution is achieved, when the construction material, the components and the facility equipment applied constitute a structural and architectural combination that meets the requirements made on the facility 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 utilization, while the expenses for maintenance and operation remain moderate, the constructional solution can be regarded as economically optimal, too. The optimal constructional solution may be found in total service offers, as the interdependencies between the single components of the facility as well as the influences of the planning, construction and operation
processes on the components and the facility on the whole can be recognized at an early point in time and can be formed deliberately. This view of the constructed facility as a system in its total life cycle brings about more and more possibilities for innovative solutions, which will be shown in the following on the example of the view of the constructed facility and the construction process as a system.

**THE INNOVATIVE POTENTIAL OF THE CONSTRUCTED FACILITY**

Portrayed in simplified terms a constructed facility is made of different components, which are structurally combined with each other and therefore form the characteristics and the total behaviour of the facility, while the characteristics of each component result from the combined action of the law of nature of one or more construction materials. The characteristics of the facility can thus be created through the construction material, the constructional principle or their mutual dependencies. Therefore starting-points for innovative structural solutions result from

- the usage of a new or improved construction material, the changed characteristics of which have no effect on the constructional principle.
  
  For example by combining special aggregates (i.e. fly ash), binders, thermal resistant materials and additives a concrete with better fire safety can be made [1].

- the usage of a new or improved construction material, the changed characteristics of which lead to new constructional principles.
  
  The development of a waterproofing membrane for shotcrete coatings, applied 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 leads to a considerable reduction of material requirements [2].

- the usage of a constructional principle that makes use of the existing characteristics of construction materials in a new way.
  
  Segmental bridges with external prestressing can serve as an example for the new structural design of a constructed facility by 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 [3].

The influence of the planning process on the constructed facility can be recognized, as the constructional principle is one of the objects of the planning process.

**THE INNOVATIVE POTENTIAL OF THE CONSTRUCTION PROCESS**

Regarding the construction process as a system one can find starting-points for innovations in this field, too. The construction process can be defined as the temporal and spatial organization of the construction methods necessary to build the facility. Every single construction method is characterized by the interaction of the construction material, the construction equipment and the operator, with the construction equipment having a specific effect on the construction material and
changing its structure, shape, position etc. The following starting-points for the innovative design of the construction process are therefore possible:

- the usage of a new construction equipment which has a changed effect on 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 [4].

- the usage of a new or improved construction equipment which has an unchanged effect on the construction material

  Tunnel boring machines can serve as an example for this. Their range of usage is constantly broadening. Machines that can either adapt to simply changing geologies (e.g. mixshields) [5] or that allow rock support behind the cutter head at the earliest possible point in time are invented [6].

- the usage of a new or improved construction equipment (either having an unchanged or a changed effect on the construction material) that allows a new organization of the construction 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 [7].

THE INNOVATIVE POTENTIAL OF TOTAL SERVICES

Up to now the possibilities for innovation with regards to the constructed facility and the construction process were shown separately, but if they are examined together, another innovative potential can be found. The element connecting the two systems is the construction material, which is a component of the constructed facility as well as of the construction process. Connecting these systems a new system is created, which can be called construction technology. From here we can deduce the actual innovative potential of total services. For example, a new constructional principle can lead to the usage of new construction equipment and to a new organization of the construction process. This can be shown on the above-mentioned example of segmental bridges with external prestressing. The structural division of the superstructure into single segments led to a new formwork system for the production of segments and new construction scaffolding for the segmental installation. At the same time the construction 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 construction period can be reduced and the quality of the superstructure can be increased considerably [3]. Considering the process of operation, too, the innovative potential enlarges in the sense that the behaviour of the constructed facility and its components can be observed over the period of usage, conclusions on the design of the construction technology can be drawn for future facilities 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 [3].

It can be stated that the innovative potential of total services is not just consisting of the single view of the constructed facility at its single life phases, but results from the early and specific consideration of the influences from the whole life cycle on the system of the constructed facility.

POSSIBILITIES FOR CONTRACTORS TO INNOVATE

Up to now a characteristic of medium-sized contractors is the fact that they offer different services (like carcass or pavement work) within different lines of business (like building construction or road construction) for the construction of a facility. Usually they only take part in a construction project at a point in time when the planning is nearly finished. This means that the contractor has to adapt the construction process to the structural and local conditions of the constructed facility. An efficient solution to the problem of adaptation is combining known and/or new construction methods. Using new construction methods can mainly be equated with the introduction of new developed construction equipment. This introduction process is well organized in the companies examined and does not have special requirements apart from the financial resources needed, because in most cases it is the introduction of continuously made improvements. As the new developments of the producers 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 the construction processes of former projects is used to change the system of the constructed facility and the construction method in a way that the construction process can be organized optimally. However, these alternative tenders 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 proofed 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 company that will realize the idea for less payment. Furthermore, especially with ideas that are new for the company it is difficult to proof the advantages of a solution (references).

- The engineer of the specification may fear a loss of image in the eyes of the client caused by an alternative tender of the contractor and accordingly he will reject the alternative solution.

- In most cases the actual tender has to be further worked on, so that an additional offer can only be provided with additional expenditures of time or staff. Often good ideas cannot be realized, 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 facility.

The problems with alternative tenders clearly show that many constructed facilities are not planned with the focus on the execution and that optimising at a later point in time and thus the possibilities of contractors to innovate are restricted. Total service offers provide these possibilities to innovate, but they can only be used, if the knowledge necessary for it has been taken into account at the earlier stages of the construction project. This is only possible, if all those who take part in the construction project cooperate and work together as partners.

INCENTIVES AND SUPPORTING TOOLS FOR CONTRACTORS TO INNOVATE

As many different interest groups are at different times and just temporarily involved with the construction project there is not only a lack of possibilities for innovation, but also a lack of incentives to innovate, for the interests of the different groups are not always orientated on the aim on the whole, i.e. the erection of a constructed facility that optimally meets the demands of the client. Total service offers can provide the framework for the necessary orientation of the 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, planners and contractors offered operation services, too, these companies would have a greater incentive to look for innovative solutions as they aim at having low expenditures on maintenance and operation of the facility 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 contractors, the client may also let the companies participate in the savings or the exceeding costs from the operation by implementing a Bonus-Malus-System. If total service offers shall fulfil the function to orientate all on one aim, it is again of major importance that all those who are involved in the project cooperate. In this sense co-operation can be defined as the voluntary collaboration of several independent companies with common and individual aims.

As developing innovative total services is a complex task along with the co-operation of participants of a building project other supporting tools have to be applied. These tools concern methods of problem solving and project management. Their balanced and common usage is the essential characteristic of value management [8]. As the methodology value management combines an interdisciplinary co-operation with different methods of problem solving and project management it provides an appropriate framework for complex tasks like generating total services. Although this paper only deals with the component of co-operation, for achieving optimal constructional solution it is necessary to apply all three components of value management consequently.
INTERNAL CO-OPERATION

The first step on the road to total service offers is bringing together services for different subsystems of the constructed facility on one level of value added. Medium-sized contractors have the possibility for internal co-operation, because they offer execution work for different subsystems of the facility (for example foundation and carcass of a building) and for subsystems of different facilities (for example road construction and tunnelling). Thus, they can use e.g. the potential for a new organization of the construction process.

As the companies are structured into regional and specialised business units, which act autonomously, sometimes hindrances for co-operation appear. If the market requires total services for a construction work, for example the renovation of a road bridge, the necessary services can be executed by one company, 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 if along with the renovation protection walls against noise have to be erected.

Here, an instrument is needed that can react quickly and beyond the limits of departments to such demands for total services. A task force formed with regards to the requirements of the problem and consisting of persons from different departments, who are only temporarily working together, can take on this task. 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 company level and is free from single interests of the departments. In this sense it can be regarded as an instrument of the top management.

If the requirements for total services were met, for example by setting up a task force, other organizational requirements have to be met, in order to be able to generate innovations within the total services, for the restrictions with regards to time and staff for working out an innovative solution is still existing (figure 1). 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 construction. 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 company.
EXTERNAL CO-OPERATION

Along with internal co-operation medium-sized contractors nowadays often make use of external possibilities for co-operation, in order to combine services for execution. 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 company are insufficient and the risks of which are unbearable for one company alone. Working as a team (contractor combination) enables the companies 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 like renting the machines or selling them back to the producer make the decision for the investment easier.

Nevertheless, the innovative 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 constructed facility 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 execution of the facility, it is possible to fill this gap using external co-operation. As it is the case in internal co-operation, organizational solutions are needed with the help of which total service offers can be generated and designed in an innovative way.
A suitable form of organization is the network of companies, consisting of independent companies that are specialized in different levels of value added (figure 2). Along with their executive work medium-sized construction companies can take on the role of a broker or system integrator within the network. Fulfilling this function, they co-ordinate and integrate the services of the participants of the network and according to the specific requirements of the construction project bring them together in virtual companies. Depending on the size of the company or of the construction project this integrative work may be restricted to subsystems of the facility or include the whole constructed facility. That is to say, different virtual companies, the services of which are in turn co-ordinated by a superordinated broker, can autonomously execute subsystems of the facility. 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.

Although strategic networks are a promising way out of the structural crisis in construction industry, their formation up to now fails because of a lack of trust that those who take part in the construction have in each other. Even though first signs of new organizational ways to carry out projects can be observed, which could open up the necessary scope for developing innovative total services, the different companies are often still only included into the process of carrying out a project as a "mere" executor.
Figure 2: forms of external co-operation

BN = basic network
VC = virtual company
BP = building project
P = partner of the virtual company
B = broker of the virtual company
SOB = superordinated broker
CL = client

form for the whole system of a constructed facility

form for subsystems of a constructed facility
CONCLUSION

This paper tried to point out that optimal total solutions for the client can only be found, if the know-how of all levels of value added of a constructed facility is used in time. At the same time, by looking at the facility as a system in its life cycle the innovative potential increases. By building up total services medium-sized contractors have the chance to make use of the innovative 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 organizational forms 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 organizations and thus helps to contribute to their successful work. However, an aspect of much greater importance for the functioning of networks and an essential part of the ability to co-operate is the development of trust in each other among the network members. 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, so that organizational solutions like networks can be successfully realized.

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