RISK MANAGEMENT IN PROJECT BUSINESS –A CASE STUDY ON THE ACQUISITION OFCONSTRUCTION PROJECTS AT BILFINGER BERGER CIVIL

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Abstract

This paper deals with risk management in project business. In particular, it examines the specific risks during the acquisition of construction projects. First of all the characteristics of the construction industry and the risks occurring during bid preparation and negotiation of construction projects are described. Then a case study explores which strategies the subject company pursues to manage these risks. In focus of the case study is the company Bilfinger Berger Civil, a large, international construction company, which is an active player in the project business and has already carried out a variety of construction projects successfully. The author deals with various aspects of practical risk management: optimization of the project portfolio, risk analysis and determination of the offer price with the help of a simulation model and the work of the company´s Project Controlling Department that monitors the high-risk projects. The risk management of Bilfinger Berger Civil is finally assessed in form of a summary. The reader gains information about theories on risk management and numerous impressions on their practical application in a real construction company.

Keywords: Risk, risk management, project management, construction industry, case study

Introduction and theoretical background

Business companies in the project business are to be characterized by several specifics, which also applies to the requirements with regard to their risk management. This can be further differentiated in terms of the industry in which the company operates. In particular, the construction sector must be characterized by some specific attributes. The classic risks of project management, such as risks of quality, cost and time of course apply to the construction industry, too, but the sector can be described in detail through some further anomalies that *Horsch* (Horsch, 2002) summarizes as follows:

- Every building project can be characterized by uniqueness
- Very often the construction contract is concluded first, and only after that the execution planning with detailed designs is done
- Large construction projects involve a high degree of technical complexity, for which the construction companies partly do not have core competences (any more)
- The technical complexity is tangent to the contractually owed functioning
- Each individual order represents a high financial volume (which is why the credit line is impacted by issuing of a contract performance guarantee and warranty bond)
- The contractual and legal warranty obligation is long (usually five, for some components even ten years), in their nature often unpredictable (for example in bad faith) and - depending on the subsequent use of the object - in addition to reparation of defects also damages-triggering.

The author points out that, in particular, the preliminary phase, consisting of bid preparation and tender, and the subsequent contract negotiations, including conclusion of the contract, involve increased risks: *"A bad contract is a bad contract. No amount of professional construction management can make up for, for example, calculation errors or realizing contractual risks (geological risk, unrealistic construction schedule with corresponding penalties, etc.)"* (Horsch, 2002). *Göcke* (Göcke, 2003) who describes the following risks that used to occurre especially in the phase before contract conclusion also took up this idea and explains the following risks:

- Risks of calculation
- Risks of final price decision
- Conclusion of lump sum contracts
- Sales-oriented behavior during acquisition

Risks of calculation

As in other industries, the price is determined by calculating in advance. Construction projects are, generally speaking, extremely complex projects with many influencing factors that need not rarely several years to be completed. A full coverage of all the construction work-affecting risk factors during the calculation phase is under an economic point of view simply not possible. For this reason, often inaccuracies or omissions used to arise in the calculation, which, as they exceed a certain level, burden the result of the project. To make matters worse, often only little time is available for the calculation of costs and the capacities are limited due to a usually low success rate.

Risks of final price decision

The final pricing is often not based on a calculation with a determined offer price, which includes premiums for risk and profit, but in separate rounds of negotiations. Here, the awarding party will require the submission of a final offer, in which often the price is the sole distinguishing feature, and on the basis of which the awarding of the contract will be made to the bidder with the lowest price. Partly this is a situation deliberately promoted by the contracting authority, which can be characterized by pressure in terms of time, competition and success on the part of potential contractors. Often discounts are given on the original price, which can only be inadequately examined and which are not accompanied by any reduction of cost or risk at the time of submission of the bid.

Conclusion of lump sum contracts

The tendency in the conclusion of contracts goes towards the conclusion of contracts with fixed prices. Contracts that include a settlement based on the quantities conducted and the provided unit prices get more and more in the background. Lump sum prices are binding for billing for the duration of the project and are independent of any increase or decrease in quantities. The Contractor may assert any additional cost during conduction only afterwards and the approval of the demand is uncertain. This affects both, the amount of the claim, and on the other hand, the timing of approval to which the project is to be funded additionally by the contractor. Thus after conclusion of the contract the project result can be essentially controlled only on the cost side.

Sales-oriented behavior during acquisition

Sales-oriented acquisition behavior is often found in connection with the previously described special circumstances of bidding and final pricing. The focus is on the sales-oriented project acquisition, but not the profit- and risk-based acquisition of projects. Since construction projects are generally characterized by a one-digit profit margin, in sales-oriented project acquisition easily such projects can be "won" that can only be conducted at a

loss and thus burden the result of the entire company. Nevertheless, there are various reasons for such behavior. For example, managers try to earn at least a portion of the contribution margin to bind existing capacities or to survive economically difficult times. In addition, this strategy is used when new markets are to be entered or the opportunity of lucrative follow-up contracts is given. Regardless of these the sales-oriented acquisition behavior is a high-risk activity, since not only the asset situation of a company forms a criterion for the company's continued existence, but also liquidity must be guaranteed at all times. The underpriced project also may be subject to additional risks that can push a project offered with calculated profit into the loss area.

Construction projects are further characterized by risks that have to be accepted as given and can often be influenced only after conclusion of the contract by appropriate work preparation, project controlling or intense claim management. In the past reduction of risks was attempted especially with the traditional means of the construction process: professional work preparation, cooperation with reliable subcontractors, taking advantage of opportunities in procurement and the use of qualified personnel. These means are neither enough to survive in the market in the future, nor to prevent runaway projects on time. Runaway projects are projects that can only be conducted with such a negative result that the positive results of numerous other successfully completed projects are nullified. A single of these runaway projects can sometimes distort even the entire outcome of a branch, a subsidiary or even the entire company into the negative range. A method by which the project risk can be reduced and the amount of the contribution margin can be increased is described by *Blecken/Meinen* (Blecken/Meinen, 2004). The authors recommend the following procedures:

- Strategic optimization of the contract portfolio
- Offer rating to select profitable projects

Under the strategic optimization of the contract portfolio essentially the orientation of the order structure on the planned or potential corporate earnings rate is understood. It follows as a conclusion that the company should refrain from taking part in tenders of unilaterally risk-intensive projects in order to optimize the project portfolio and not to burden it with loss-making projects. This path leads probably to a smaller number of projects; however, it also offers the opportunity to increase the overall result. The aim of offer rating is to avoid runaway projects even within the framework of generally permissible projects. This includes the pre-selection of the targeted market segments, the risks of which should be included in the individual valuation of projects, as well as verifying each individual project before bidding in terms of specific risks. In case of the identification of individual risks, the offer price can then be raised with predetermined risk premiums. It should be noted that the embedment of risk premiums into the price is very difficult due to the market situation, as competition usually is decided by the price and factoring in of risks may lead to a safe margin, but contract awarding can not be expected in every case.

Bilfinger Berger Civil at a glance

Bilfinger Berger Civil comprises the Group's activities in this area of construction, the business is focused on demanding infrastructure projects. The company ranks among the recognized suppliers for large infrastructure projects and was able to work out an excellent reputation. The expertise of the company is concentrated in specialized units, whose competence the strong competitive position is based on. These include the core technologies bridge construction, tunneling, transportation infrastructures, civil engineering, hydraulic engineering and water technology.

The focus of the business is on international markets, selected European and African countries, the Gulf region as well as in Germany. Although being a German company, about 80% of the revenue is generated abroad. The business is affected by the strong dependence on

public investment and the business cycle as a whole. Furthermore, clients often base their project awarding policy exclusively on the cheapest offer without rewarding quality sufficiently. Another characteristic is the relatively high radiation effect of individual risky projects on the earnings situation of the whole company. Regardless of this, the list of projects handled is very impressive, and includes the largest offshore wind park in the world off the coast of Denmark's with 91 wind turbines. In Doha, Qatar, the company built a completely new urban area for 20,000 inhabitants, consisting of the turnkey construction of about 6,000 apartments in total and a contract value of over 1 billion Euros. In Switzerland Bilfinger Berger Civil is involved in the construction of the Gotthard Base Tunnel, this occurs at a depth of 800 m and will be the longest railway tunnel in the world after its completion with a length of 57 km. In 2008 Bilfinger Berger Civil generated a turnover of more than 4 billion Euros and had a workforce of more than 14,000 employees.

Optimization of the project portfolio

In 2009 Bilfinger Berger Civil introduced a new system for the classification of projects that on the one hand has the goal of supporting the decision about submitting a bit on a tender and on the other hand is used to control the mixture of the project portfolio. The aim is to take only such risks that are measurable and controllable by the company. In the focus of the project evaluation stand the form of contract and the acceptance of budget or quantity risks in case of a contract. The projects are classified into four different risk classes whose two essential criterions are defined as follows:

- Risk category 1No budget or quantity risk,Reimbursement of cost-contracts or orders smaller than 10 million Euros order value (in case of reimbursement of cost-contracts the contractor is entitled to charge the costs incurred plus an agreed margin)
- Risk category 2Limited budget or quantity risk,Unit-price-contracts or ontracts with up to 10% lump sum content (in case of unit-price-contracts the contractor is entitled to charge the built and approved units multiplied with the agreed unit prices)
- Risk category 3Complete budget or quantity risk,Lump-sum-contracts or unit-price-contracts with more than 10% lump sum content (in case of lump-sum-contracts the contractor is entitled to charge the agreed price, less or more units do not entitle to any changes in price)
- Risk category 4Budget or quantity risk not measurable, Disadvantageous contract clauses and incalculable risks

Furthermore, the size of the project, previous experience with the client, cooperation with partner companies, the technical and logistical complexity of the project and the available construction time are evaluated during the classification of the project as well. These are the criteria for classification of a project to a risk category, on the basis of which subsequently the decision is made whether or not to take part in the tender. Especially for large projects, which are often technically demanding and provide by their contractual, financial and logistical complexity high demands on the project organization, also other aspects still serve as a basis for discussion to assess the attractiveness of the project. In this context, the market attractiveness is judged according to the following factors: market growth, market access, competition, profit potential, as well as partner and subcontractor availability. The project risks include staff availability, project size, technical expertise, client behavior, market knowledge as well as the contract and payment conditions. Each criterion is assessed separately to classify the project into one of four risk classes. A detailed overview of the different risk categories is given in *Table 1*.

Risk category	1	2	3	4
Budget- and quantity risk	No or low	Restricted and containable	Distinct, completely	Not measureable, incalculable
Contract type	Alliance- or Cost+Fee- contracts (Contracts for reimbursementofcosts)	Unit price contracts, including partly consolidation into a lump sum up to 10% and with a small part of design planning	Lump sum contracts or unit price contracts with consolidation into a lump sum above 10%, Design- and Construct contracts	Adverse contract terms, not manageable or not affordable risks
Project size	up to 10 million €	< 200 million €	> 200 million €	
Client		New or irregular customer, that is known as competent / not hard to work with	New or irregular customer, that is known as hard to work with	Client is known to be little competent
Labour community		Bilfinger Berger has technical or commercial leadership	Partner company has overall control (leadership)	No or very small possibility for control on behalf of Bilfinger Berger
Technical and logistic complexity		From small to high (standard methods), responsibility at Bilfinger Berger	Very challenging, responsibility at Bilfinger Berger	Very challenging, no or small responsibility at Bilfinger Berger, Partner- or subcontractor Know-How necessary
Construction time		Sufficient (has spare time)	Very tight (no spare time), but presentable	Not presentable

Table 1: Risk categories for project evaluation
Source: Civil News, Employee magazine of Bilfinger Berger Ingenieurbau GmbH, Issue No. 1/2009, Wiesbaden, Germany, 2009, p. 5.

If, depending on the various criterions different risk classes apply for a project, so for the final rating of the overall project always the highest classification of a single criterion is taken into account. Within a year after the introduction of the project evaluation with the help of risk classes and risk profiles positive results have already been achieved, justifying the optimization of the project portfolio as the right path. The following positive effects were registered in detail:

- A clear shift from high risk to middle risk and low risk projects
- A clear shift from mega-projects with an order volume of over 1 billion Euros to large and middle size projects
- Significantly more intense dealing with risks on all levels of management

With the help of the presented risk classification, initially the existing risk profile of the individual business units was analyzed in order to develop the future desired target profile. Then provision is made not to conduct projects in risk category 4, which are accordingly generally no longer offered. In addition, the share of projects with risk class 3 shall be reduced to below 50% of the total portfolio. Accordingly, the proportions of projects in risk categories 1 and 2 are to be expanded, which should account for more than half of the future project portfolio. Both in the past and in the future projects in risk class 3 have an over-proportional share of the total portfolio, which can be explained with the fact that many construction projects are tendered as lump sum contracts. Nevertheless, the focus of project execution shall be clearly directed to those projects that can be characterized by a balanced

distribution of risks between client and contractor. The percentage distribution of individual risk categories within the current and future project portfolio can be seen from *Figure 1*.

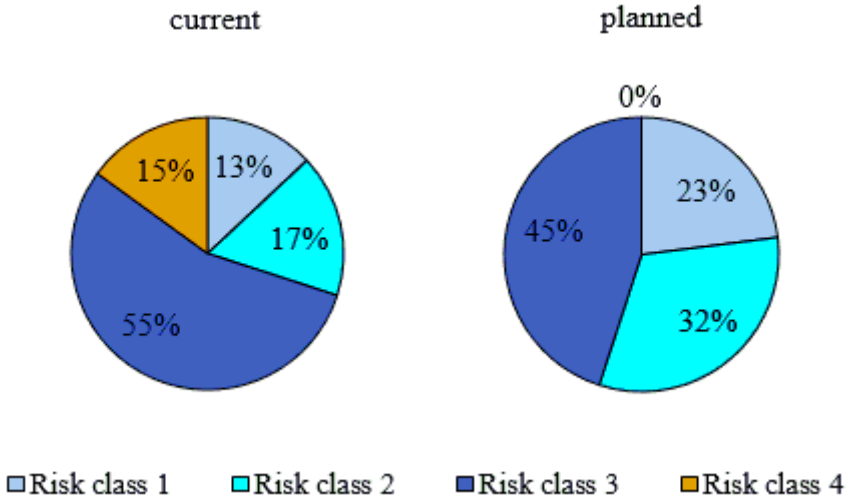

Figure 1: Distribution of Risk categories
Source: Civil News, Employee magazine of Bilfinger Berger Ingenieurbau GmbH, Issue No. 1/2009, Wiesbaden, Germany, 2009, p. 5.

Risk analysis with the help of the Cassandra-Tool

The Cassandra-Tool is an instrument with help of which Bilfinger Berger Civil specialists analyze quantifiable risks statistically. Essentially, it is based on the Monte Carlo simulation, in which a variety of different scenarios is generated in order to draw conclusions from the distribution of the results with respect to the considered risk. The Cassandra-Tool is utilized particularly in the bidding phase of projects, for example, when the influence of individual risk factors on the overall project shall be predicted or a likely outcome of the project is to be calculated. The method consists of three steps which are applied one after the other:

1. Identification and analysis of opportunities and risks with regard to the individual components of the offer price
2. Evaluation of the preceding considerations with help of the Cassandra-Tool
3. Presentation of the analysis and consideration in the offer price

The offer price is according to the model made up from the calculated profit as well as four types of costs: direct costs of subcontractors and materials, indirect costs of staff, rent, etc., costs for extraordinary risks and opportunities and costs of price increases. With exception of the profit all the above categories can be added another category with help of the Cassandra-Tool: variable costs of risk premiums. First, opportunities and risks in relation to the four types of costs are determined in the first step of the process. For this purpose, a risk workshop is conducted, in order to analyze the identified opportunities and risks, for example, by estimating the probabilities of occurrence or interdependencies. For the direct costs and the indirect costs the best case, worst case and the likely case are determined, similar to the offer calculation separately for quantities and prices. In the presence of extraordinary risks or opportunities, in addition the probabilities of these are estimated as well as in case of anticipated price increases assumptions are made for their eventual extent. Thereafter, the individual values for quantities and prices are multiplied with each other. Already at this stage first further analyzes can be carried out. Thus it can be seen how much of the calculated scenarios lead to costs below a certain threshold (cumulative frequency) or how many scenarios end within a predefined interval of costs (distribution function). Furthermore, it can be decided whether and to what extent a variable risk premium shall be

set up that will be part of the final offer price. This procedure is then repeated for each type of cost and each particular risk factor. This results in a Monte Carlo simulation with a variety of different scenarios, each leading to a specific offer price. The distribution of the total cost can very well be illustrated graphically, for example the intervals of costs on the x-axis and the number of scenarios within an interval on the ordinate axis of a two-dimensional coordinate system.

During the second step of the Cassandra program the foregoing considerations are analyzed and the graphs obtained evaluated. While with the conventional approach no information about the range between best and worst case is available, with the help of Cassandra-Tool new insights can be gained. They include:

- the progression of the project costs and the associated sub-exceedance probabilities between best-and worst-case
- the expected spread of the project costs
- differences between projects with high uncertainty regarding costs and low uncertainty regarding costs
- the sub-exceedance probabilities of costs calculated with the conventional approach
- identification of advisable risk premiums

In the third and final step, the findings of the analysis are processed for decision-makers in a standardized presentation of results. This includes the evaluation of the distribution curves and the review of the analyzed input calculation in order to possibly incorporate reserves in the calculation, which are intended to ensure that the predicted costs are not exceeded. Furthermore, the topics with the highest risk and opportunity potential or the greatest impact or the greatest uncertainty are presented in order to take them into account accordingly in the future project control. In addition, the presentation of results includes a written report with an interpretation of the findings. The benefits of Cassandra-Tool can be summarized with the following points:

- The project team deals in a structured way with opportunities and risks.
- All uncertainties will be further examined with the same methodology, the calculated effects are therefore comparable.
- It is possible to take dependencies and links between the different uncertainties into account.
- The model allows one to infer both individual risks, as well as the overall risk.
- The calculated scenarios can be compared with the calculated costs and risk premiums, but also with the results of other methods.
- The amount of reserves or risk premiums can be determined that are needed to achieve a certain level of security or a sub-exceedance probability.
- The project team can focus their work on the significant risks.

However, regardless of the usefulness of the instrument, the model also has limitations that should be considered in its application. The Cassandra-Tool is a useful component in risk management, but it represents only a single part of it. The results obtained must be compared with the estimates of other methods and then scrutinized. Furthermore, it must be noted that the model can reflect only what has been previously assessed. The quality of the data generated by the model is very closely connected with the quality of the data entered by the user. Cassandra is "only" a computer-based analysis algorithm that neither is being able of discrete thinking nor makes assumptions or evaluations. However, the instrument is to support decision-making, it cannot replace it. This is also underlined by the handle that responsibility for the adopted estimates and content of the risk assessment remains with the project team.

Monitoring of projects by the central Project Controlling Department

The central Project Controlling department monitors individual projects in the bidding phase, the negotiation phase, as well as in the execution phase and plays an essential role in the management of project risks.

The monitoring process begins with the bidding phase of a project. At the beginning, the operational unit that is in charge for the project has to fill the so-called "Offer Notice Sheet". This is a form that contains a number of risks and project characteristics in a standardized format, and categorizes them according to their extend. The form has to be submitted at the beginning of the offer preparing process by the respective operational management to the central department with all available information at this time. The central department checks the information and considers whether there is any criteria that justifies the refusal of approval to tender and agrees this with the management of the operational area and the responsible board member. If the evaluation of all criteria leads to an overall to negative impression, bid preparation and tender is called into question, but it is being tested in each case, what criteria are negotiable and whether the risks can be excluded in the offer. As part of its task, the Project Controlling department analyzes and rates the bid preparation in terms of quality of bid processing, engineering, contracting, estimating, construction time, personnel and organization, as well as risks and opportunities. At the same time, the central department decides about the future intensity of monitoring the project at which the following options are possible:

- Due diligence of the entire project
- Observance of certain portions of the project
- Monitoring of the project during the entire bid preparation
- Attendance at the final calculation meeting
- Consultation of other in-house departments
- Consultation of external special advisors

In the analysis of the offer the preliminary bid amount, the risk review, pointing out of how and where the risks have been considered in the offer and personnel planning are the fields of special importance. If necessary, the central department sets up a supplementary report for the Executive Board. The responsibility for complete and accurate bid preparation and the implementation of the recommendations by the central Project Controlling always remains, however, at the relevant operating unit.

After submission of the offer by the operational unit the central department monitors the project, where appropriate up to contract award. During this time, the operating entity is required to forward all information about the development of the project regularly and promptly to the corporate headquarter. Here contractual changes of any kind compared to the agreed terms of the offer are of particular importance, especially changes of contract terms, or increases or decreases of services and changes in the construction time or interim deadlines. Other focal points of observation are on the withdrawing of exclusions in the offer, discounts, the extension of the offer-binding period or bid bonds and of course changes in the risk profile of the project. Before signing of the contract, the Project Controlling finally checks any negotiation results.

Projects that have been monitored by the central department during the offer phase are usually observed after placement of the order, too. However, so-called risk projects can newly be included in the monitoring process. These projects are already in the construction phase, however, have not been checked yet. These projects are characterized by abnormalities or signs of higher levels of risk, which the central department tries to counteract by more intensive care. The following criteria are used to define risk projects:

- With regard to the entire project:

Difference between current profit forecast and the profit that is still needed to reach profit plans > -5%

- With regard to the fiscal year:

  Difference between current profit forecast and original profit forecast > -5%

If a project is monitored during the construction phase, the project management is required to make all requested contract documents or other documents available to the headquarter and to prepare regular monthly and quarterly reports. The central Project Controlling, for example, takes part in supervision meetings and regularly collects information about all relevant procedures and measures influencing the project, the progress of construction and other technical concerns. In addition, commercial details are checked, such as the result of the construction site at the reporting date or the result forecast for the end of construction time. In summary, the central department analyzes and evaluates projects in the execution phase in terms of quality of construction management, engineering, contracting, performance and result, construction time, personnel and organization, as well as risks and opportunities. Furthermore, audits are performed, reports and analyzes generated about risk factors and possible project control measures suggested. As in the offer phase responsibility for the proper execution and implementation of the recommendations remains in the relevant operating unit.

Parallel to the project monitoring the central department also reports to higher-level units. Reports will be provided to the project managers, as well as their line manager and the responsible Board member. Before finalizing and distributing the reports and analyzes are sent to and discussed with the relevant project managers. In case of a different opinion the project management can represent their dissenting view in the reports.

Conclusion

The internal control system of Bilfinger Berger Civil was mainly driven by organizational measures. This includes primarily the creation of several specialized central departments. The presence of an internal audit is explicitly required by the legislative side, but other central departments, such as the Project Controlling, monitor the risk situation of the company and thus contribute to a legally compliant risk management structure. Risk management does not exist separately, but was integrated into the existing reporting structures and thus into the existing process structure of the company, whereby it is present at all levels of the Group.

A special position within the company comes to the central departments. In them, the expertise in the respective area is bundled to support and advise the operational units in their business. Important legal cases and contracts are handled by the Corporate Legal Department. The Treasury Department acts as the in-house bank for the entire group, while the Group Controlling collects the detailed reports of all business units. The Internal Audit Department and the Project Controlling accompany projects of outstanding importance or in individual cases if necessary. Many processes run together in the company's headquarter, the departments are at least given a voice in a variety of decisions. Furthermore, the central departments provide regular reports, such as quarterly or as separate risk reports, which support the Board in its work. On the other hand, the importance of corporate departments must not be overstated. On one hand, different thresholds are applied in reporting or in selecting projects to be observed. Therefore, not every project is accompanied through all phases of project life cycle and decision-making is delegated to intermediate management levels. On the other hand, the capacity and the number of employees in the corporate headquarter are limited, resulting in the necessity to focus on priority activities and apply broad guidelines. A centralized risk management does not exist. Neither is a central Risk Management Officer in charge, nor a risk management department installed as an

independent department. Rather, the principle of integration has been implemented, risk management is integrated in the organizational structure and the line functions of the company.

In addition to the advantages already described, however, the risk management system at Bilfinger Berger Civil has its limits, too. For improvement, among others is the field of tools for project management. The shortcomings do not concern the instruments themselves, but rather their systematization and universal utilization. With a comprehensive reporting system, ongoing project calculations and a conscientious determination of performance the common tools of project management are available in the company Bilfinger Berger Civil. These should allow a professional risk management and thus also a professional project controlling. However, there are improvement opportunities in dealing with these instruments. Employees are not always familiar with all the elements of project controlling or cannot safely handle them. This cannot be generalized because of the rising complexity of the projects and the increasing demand for training and experience of the personnel employed, however, weaknesses in individual cases cannot be excluded. For example, the project calculation is not continuously updated or uncertainties in the determination of performance appear.

The rules and regulations of the risk management system are in addition to its backbone at the same time also its limits. Thus, the existing schemes can be used, of course, only if employees also know them. For this purpose, there are several media available, such as circulars, the e-mail system or the group-wide intranet, but not all employees do always have regular access to these media. For example, on construction sites, access to the intranet is not always ensured, larger construction organizations sometimes also use own e-mail systems or individual employees are not on the distribution of circulars. It is therefore impossible to ensure full and to monitor the actual compliance with all rules and regulations.

Additional potential for conflict is caused by the "human element" in the project management, the fact that in all positions people with individual characters work, possessing subjective perceptions, vanities and other human weaknesses. The cooperation between the two endpoints of the Group hierarchy depends to a large extent on the personalities of the employees involved. Is it weakened by personal factors, asymmetry of information, delays and other conditions may arise that complicate the management of emerging risks. The "human factor" comes also into play, when the employees are not aware that they themselves are the first and most important risk managers. In this respect, Bilfinger Berger Civil, however, is classified as a model, since in various media, the employees are named repeatedly as the most important risk managers.

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