Third International Conference on Construction in the 21st Century (CITC-III)
"Advancing Engineering, Management and Technology"
15-17, September 2005, Athens

Quantitative Risk Management Model for General Contractors

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Abstract

European general contractors are facing two major challenges: First, in their operational business several general contractors gathered significant losses by building turn key projects. It became obvious that risks cannot be covered by a global, unspecified risk premium. Secondly, clients of the European cnstruction industry are increasingly asking beside low investment costs for minimized operating costs during the life-cycle of a building. This will encourage general contractors to provide life-cycle oriented total concepts as part of their core business in the future. Taking into account cost, schedule, quality and functionality risks associated with risk of cost guarantees for the operating phase demands integral risk management that encompasses both the project risks and general corporate risk. The basis for corporate risk management is the systematic risk management process at project level. The subsequent aggregation of risks within the whole company leads to a bandwidth of total corporate risk costs. Risk bearing capacity is determined by the resources available to cover any occuring risks. The potential risk burden of a company must be adjusted to match its risk bearing capacity. Quantitative risk management permits general contractors to attain their planned budget in a risk-oriented way and thereby improve their commercial results.

Keywords

Quantitative risk management, general contractor, risk bearing capacity, risk aggregation, Monte Carlo Simulation.

1. Introduction

European general contractors are facing two major challenges: First, over the past few years in their operational business many European general contractors gathered significant losses by building turn key projects. It became obvious on one hand that risks cannot be covered by a global, unspecified risk premium and on the other hand that they need a tool to display, analyze and control the total company risk. Secondly, customers of the European construction industry are increasingly outsourcing services during the whole life-cycle of a building with the result that there is an increased demand for total service provision. They are increasingly asking beside low investment costs for minimized operating costs during the whole life-cycle of a building (Girmscheid, 2000). This will encourage general contractors to provide life-cycle oriented total concepts as part of their core business in the future. Taking into account cost, schedule and quality risks associated with risk of cost guarantees for the operating phase demands integral risk management that encompasses both the project risks and general corporate risk (Busch, 2004).

Based on these considerations, the Institute for Construction Engineering and Management of the Swiss Federal Institute of Technology Zurich SFIT has developed the model of an integrated, quantitative risk management which consists of two associated approaches (figure 1):

1. *Top-down approach:* The company's ability to take risk is determined by the risk bearing capacity which has to be quantified and is limited to the company's financial resources. It is divided and assigned to the different strategic business units as risk limits.
2. *Bottom-up approach:* In each single project risks are identified and systematically estimated. The amount of risk costs in the bid price depends on market conditions. Residual risk, which can't be transferred to the client, has to be aggregated for the various company levels.

The quantitative risk management (QRM) has to adjust the accepted residual risk of the bottom-up approach periodically to the different risk limits of the risk bearing capacity established by the top-down approach. The SFIT in cooperation with the Association of Swiss General Contractors (VSGU) has carried out a research project to establish the processes and approaches required to accomplish this.

2. Risk definition and risk categories of a general contractor

A risk is the possibility of a significant deviation from a intended target (Chapman and Ward, 1997). The purpose of quantitative risk management is not to avoid every possible danger of a commercial venture. It is indeed the knowing acceptance and appreciation of risks which characterizes an entrepreneur. Successful companies usually understand how to only take on those risks where the apparent opportunities are significantly greater than the associated threats. Risks of a general contractor can be divided into seven main risk categories, which are market risk, competitive risks, performance risks, financial risk, management and organizational risks, social and ecological risks and project risks (Busch, 2004).

3. Quantitative risk management (QRM)

A general contractor is threatened either by *insufficient liquidity* or *excessive debt.* To prevent this, it is necessary to adjust the total potential risk, consisting both of already assumed and forthcoming risks, to the current risk bearing capacity of the company, which is limited by the available financial resources. Implementing integral QRM involves the following steps:

- Risk aggregation at different levels (project, branch, SBU or corporate level, figure 1), starting with the total risk of an individual project up to the total risk of the whole company, which forms the basis for establishing the potential risk liability (bottom-up approach).
- Establishing the risk bearing capacity from the resources available for covering risks at both the liquidity and debt stages (top-down approach) and derivation of risk limits.

- QRM requires at each level of aggregation the comparison and adjustment of the risk bearing capacity and the accepted risk potential and successive controlling.

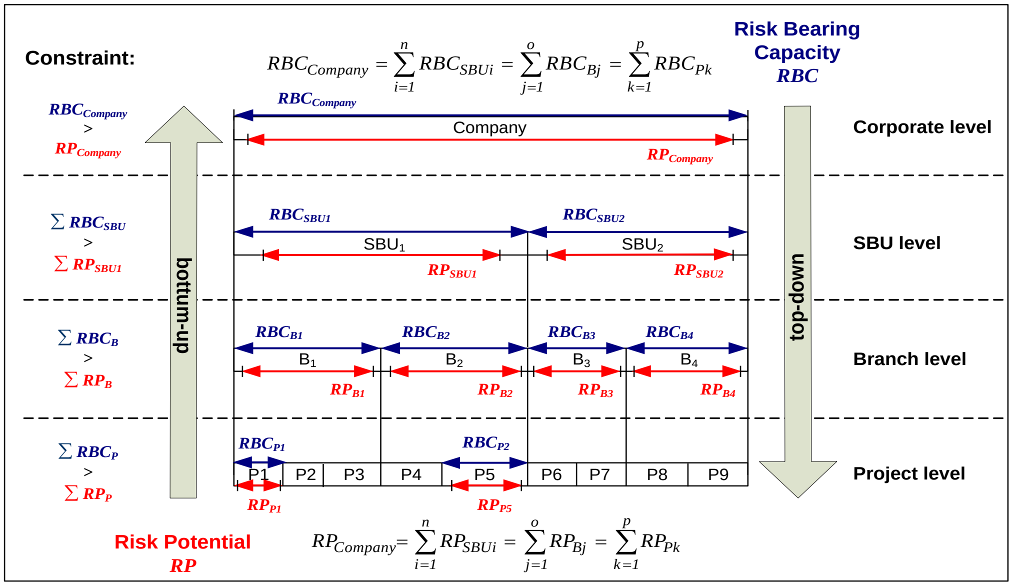

Figure 1: Quantitative risk management model

3.1 Risk aggregation at different levels – bottom-up approach

The risks of a general contractor can be analyzed and controlled at different aggregation levels. *Singular aggregation* combines all evaluated risks of a project that must be borne by the general contractor. Risk aggregation requires a risk analysis of every project. Systematic risk management at project level is a process. It consists of risk identification, evaluation, classification, risk response, estimation of the risk costs and controlling (Girmscheid and Busch, 2003). In the bidding phase the potential projects must be selected with an eye on the risk involved and, if they are chosen, adequate risk costs must be determined. The *superposing aggregation* of the assumed risks builds on the singular aggregation by aggregating the individual total risk of each project into the total risk of all projects either of a branch office, a strategic business unit (SBU) or the entire company. On company level the superposing approach leads to the total operative risk. The risk aggregation is based on the statistical formulas and the fundamentals of the Monte Carlo Simulation (Hertz, 1983 and Vose, 1996). The establishment of the risk potential *RP* is based upon the probability distribution of the total of the expected earnings of the company. This distribution is obtained by overlaying the probability distribution of the total risk of all projects on a certain level (branch, SBU or corporate level), with the contractually agreed risk premiums and the calculated profit for the corresponding individual projects (figure 2).

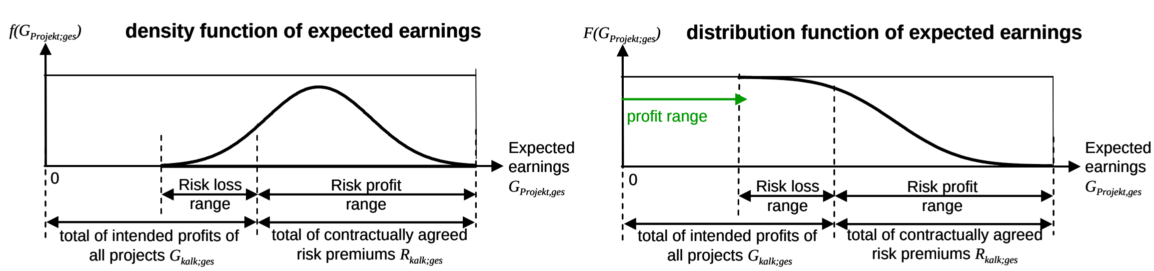

Figure 2: Density and distribution function of expected earnings (Busch, 2004)

3.2 Risk bearing capacity (*RBC*) and risk security assets (*RSA*) – top-down approach

The risk bearing capacity *RBC* depends on the resources within a company to cover risks (risk security assets *RSA*). They display differing qualities due to the complexity of their availability and the procedure for using them. The more difficult it is to use a particular *RSA*, for example, the share capital of a corporation, the less often it should be utilized. Three classes of *RSA* can be distinguished (figure 3).

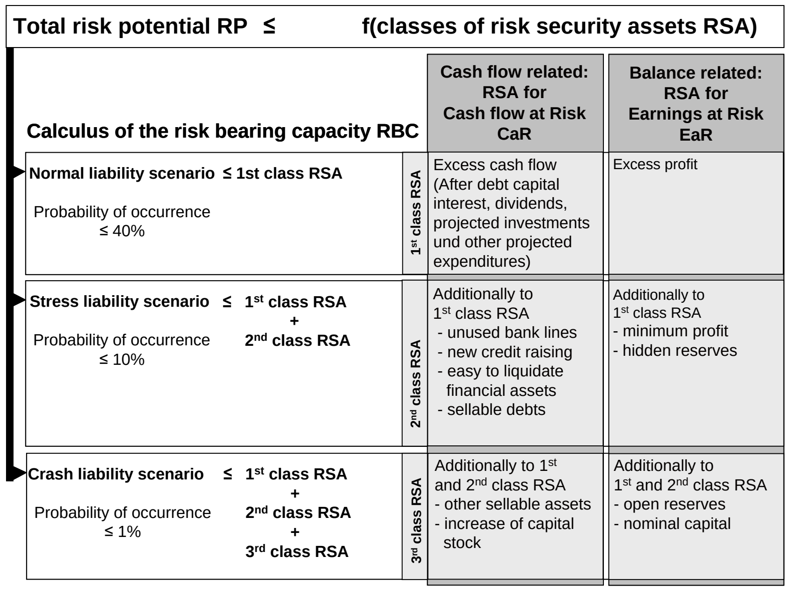

Figure 3: Risk liability scenarios and corresponding classes of risk security assets (Kremers, 2002)

1. First class risk security assets (RSA_1) cover risks that have a high probability of actually occurring.
2. Second class risk security assets (RSA_2) are used to prevent serious consequences for the company and are far less likely to be necessary.
3. Third class risk security assets (RSA_3) consist of resources that would only be used to cover liabilities in extreme emergencies, as their use would have considerable negative effects on the company.

The *RBC* is faced by the risk potential *RP*. The classes of *RSA* shown above can now be applied to meet various risk liability scenarios with differing occurrence probabilities levels which represent different risk potentials (Schierenbeck and Lister, 2002):

1. Normal liability scenario: The normal liability scenario will occur with a very high probability of, for example, 40%. Variations from the expected profit or cash flow are common within this scenario. Only RSA_1 will be held available because of the high frequency of occurrence.
2. Stress liability scenario: It will occur with a low probability of, say, 10%. The risk potential exceeds the RSA_1 and must additionally be supported by RSA_2.
3. Crash liability scenario: It will occur with only a very low probability of perhaps 1%. Its occurrence requires additionally the mobilization of RSA_3 as this scenario endangers the future of the company.

3.3 Risk controlling – adjustment of risk potential *RP* to risk bearing capacity *RBC*

Establishing the periodic risk potential on different levels (branch, SBU or corporate level) is achieved by using the *VaR* concept (Kremers, 2002), which may be based on two different risk liabilities. The so-called

Cash flow at Risk (CaR) provides a suitable indicator with respect to the liquidity-related risk liability. It expresses the maximum negative deviation of actual cash flow from the expected cash flow during a planning period that will, with a stated probability, not be exceeded. With regard to the balance-related risk liability, the potential deviation of profit from the planned profit for the current accounting period must be established (figure 4).

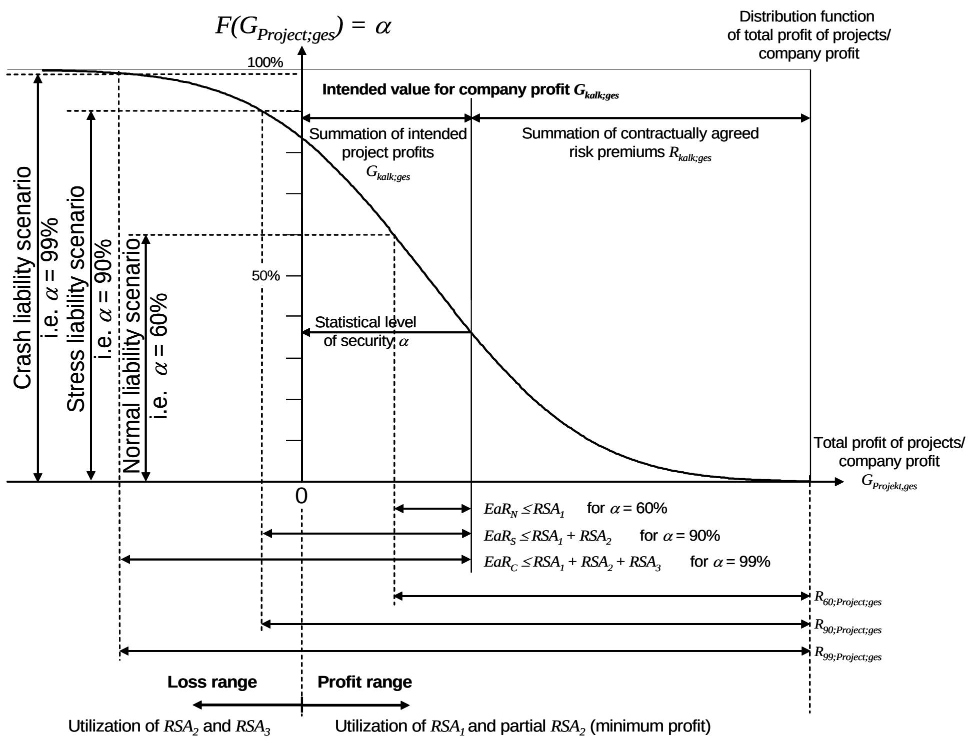

Figure 4: Liability scenarios and required *RSA* (Busch, 2004)

The corresponding *VaR* is known as *Earnings at Risk (EaR)*. These two indicators, each with the relevant risk bearing capacity that corresponds to the available risk security assets, can now be compared for each future planning period. The risk liabilities shown by the cash flow-at-risk and the earnings-at-risk must never exceed the corresponding risk bearing capacity for the different scenarios. The following condition expresses this situation:

total risk potential established RP $\leq$ *Risk bearing capacity RBC = available risk security assets RSA*

In principle, the *RBC*, consisting of the *RSA*, determines the acceptable risk potential *RP* of the whole company. Any potential negative variations of the probabilistic, project-related company earnings $G_{Projekt;ges}$ from the desired company earnings $G_{kalk;ges}$ have to be covered by the *RBC*. Before their acceptance, new risks to be assumed must be aggregated with the already accepted risks from other projects and compared with the *RBC* of the company.

4. Conclusion

Quantitative risk management contributes to risk-oriented realization of intended earnings and increases the entrepreneurial success. By its application, it is possible for the management to gain at any moment an overview of the total risk situation. From the point of view of professional risk management, general contractors which can offer a life-cycle-oriented service range will play a dominant role in the building industry compared to (simple) service providers as they convert service intentions into service results while minimizing the risks. The risk management model presented here can be applied to all companies within the building industry and other industries with a high level of project business.

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