TÉCNICO LISBOA

# Financial Risk Analysis

## applied to an international project's contract

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Dissertation to obtain the Master Degree in

## Civil Engineering

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# 1 INTRODUCTION

Given the changes in a global economy and new business opportunities in the construction sector, international ventures contain high levels of risk and uncertainty arising from the political, cultural, economic and operational environment in which locates the enterprise. Thus, considering relevant base information, a reliable risk-integrated Cash Flow forecast is needed, taking into account the inherent risks of an international construction project, not only to identify the possible negative consequences in that particular project, but also in other simultaneously undergoing projects and the company's viability itself.

The present dissertation aims to develop a methodology in order to deal with the importance of the allocation of financial resources inside the context of an international project's contract, in line with the process of risk management defined by the ISO 31000:2009. Initially, this dissertation develops the state-of-the-art with the focus in the normative framework and the contextualisation of the risk in the construction sector (in particular with risks related to financial factors and international ventures). Based in the information obtained and in the existing risk assessment models, processes and tools related to the construction sector, the proposed methodology was developed in order to analyse stochastically relevant risks, both the inherent to the execution of an international project and the related to the macroeconomic factors, and, consequently, to analyse their impact on the project's cash flow. Through the Monte Carlo simulation method, the proposed methodology was applied to a case study. Based on the case study, the relationship between relevant risks, and their possible consequences to the project, was analysed, namely those related with the location (in foreign territory), financial factors and project's activities.

# 2 STATE-OF-THE-ART

The state of the art briefly outline the concepts related with risk and uncertainty, and describes a normative framework of risk management and construction risk management models. It also highlights the differentiators aspects in relation to risks related to financial factors and international projects, and, respectively, assessment's techniques/tools.

Based with the risk definition brought by the ISO 31000:2009 norm, which reflects the consequences of the uncertainty related with the comprehension and/or the frequency of an occurrence in the organization's established objectives.

According to this standard, the structure of risk management is divided into the following components: planning, implementation, monitoring/review and continual improvement. The implementation refers to the process to managing risk, which is composed by the following nuclear activities: Establishing the context, Risk assessment, Risk treatment, Communication and consultation and Monitoring and review. According to Sousa (2012),

According to Sousa (2012), the Establishing the context is an activity that constitutes the basis for the other activities from the process to managing risk, since it determines the type, nature, quantity and quality of the results, in view of the proposed objectives from the organization. The Risk assessment, following the ISO 31000:2009, comprehends the risk identification, analysis and evaluation, providing to the concerned parties and decision making process, a better risk impact comprehension, face the defined objectives, and a informed base to the appropriated selection of measures and control processes to deal with each risk (IEC/ISO, 2009). It should be noted, however, that several methodologies have been proposed, outside the normative context of the 31000:2009, focused on the civil construction sector. Despite the notable differences between models, there are a crosscutting notion that there must be a symbiotic relationship between risk management and the project/organization management model/framework.

Mustafa and Al-Bahar (1991) point out that most organizations, in the construction sector, have developed a series of empirical rules over time to deal with risk variables in a project (e.g. weather conditions or bankruptcy). However, these rules based on accumulated experience and intuition, with the increasing complexity of projects, currently fail to anticipate and respond to face the risk in construction projects (Mustafa e Al-Bahar, 1991). The academic community (Chapman, 2001; Edwards and Bowen, 1998; Hastak and Shaked, 2000; Tang and Leung, 2005; Mustafa and Al-Bahar, 1991; Tah and Carr, 2001c; Walewski and Gibson, 2003; Xenidis and Angelides, 2005; Zhi, 1995) stress out the necessity to address the assessment of financial risks, in view of their relevant consequences for an undertaking project (delays in carrying out activities and cost increasing). The relevance of the financial risks issue, increases exponentially when it comes to international construction projects, given the vulnerability of the latter to a variety of interdependent factors. Thus, several risk assessment techniques were developed in international projects with different levels of depth and complexity, with a special focus on the host country's effect on the performance of the international enterprise(s). Despite the different techniques/tools orientations (market entry, host country impact or cash flow/profitability of the project), it's pointed out that the different risk factors, identified by the latter, have similarity in the choice of risk factors, with particular emphasis on financial/economic factors.

# 3 METHODOLOGY

For the development of the proposed methodology for the financial risk management process on the physical-financial schedule of international projects, from the point of view of the construction organization, an idiographic approach was sought that could be applied both in the preliminary phases of the presentation of the proposal, and during the construction phase of any type of civil construction's projects, with due focus on international enterprises.

Project Management is divided, both by the PMBoK (Project Management Institute, 2008) and the ISO 21500:2012 (ISO, 2012), in process groups, which incorporate among themselves several knowledge areas. In the planning/monitoring processes groups, it can be found the project time management and the project cost management areas, in which lies the focus of the present methodology. The PMBoK establishes relations between the e**stimate activity resources** and **develop schedule** processes and the **estimate costs** and **determine budget** processes, in order to be developed in a coordinated way for an optimized project planning. Therefore, with the joint addition of the project's schedule and cash flow, the physical-financial schedule is formed, on which the present methodology concentrates. The developed methodology thus aims at stochastically analysing relevant risks, both those related to the execution of the international enterprise and those to macroeconomic factors, and, consequently, analyse their impact on the project's schedule and cash flow.

Considering the intrinsic nature of each organization and the normative framework, this dissertation will focus on the activities of Establishing the context and, in the case of Risk assessment, on the risk identification and analysis processes. The schematic representation and the activities and stages covered by the proposed methodology are represented in the Figure 3.1.

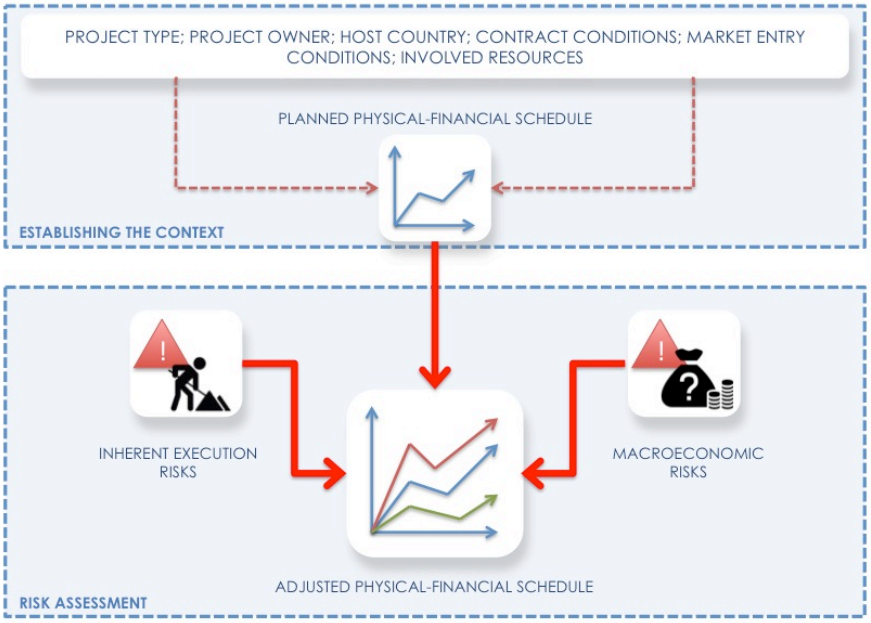


Figure 3.1 – Proposed methodology's schematic framework

**Establishing the context**

The framework of the external context, has the objective to portray the environment where the organization is inserted, characterizing the existing forces with influence in the organization's objectives and the interested parties in the success of the latter. This stage involves the characterization of the following points: **Project Type**; **Project Owner**; **Host Country Characterization**; **Contract Type**. In terms of the setting of the internal context, this characterizes the organization's environment, taking into account its structure, adopted

models and the organization existing inputs that may be useful for the risk management process (Sousa, 2012). This stage involves the characterization of the following points: **Market Entry Conditions**; **Identification of the Company's Assets Involved**; **Planned Physical-Financial Schedule**.

**Risk Assessment**

This activity focuses on the characterization of risk identification and analysis. The Identification process comprehends, among others, the systematic tasks of researching and structuring the risks presents in an international project. The present methodology advocates a classification according to the nature of the risks, and in the subdivision of **inherent execution risks**, in the project, and in **macroeconomic risks**, independent of the project in question. The risk analysis implies the elaboration of the study and combination, of the identified risks, tasks. As for the study task, this may involve the selection of the risks to be analysed and implies the estimation of their likelihood and their consequences on the project's physical-financial schedule. It is also important to draw up a preliminary qualitative analysis as a basis for selecting the risks that will be submitted for a quantitative analysis. After the estimate of the distribution of the likelihood and consequences and eventual correlation coefficients between the risks analysed, the combination task is carried out on the project's physical-financial schedule. In order to aid in the combination task, the proposed methodology adopts the Monte Carlo simulation method (also present in Han et al., 2014), involving random sampling algorithms and/or random number generators, reflecting the impacts on the project's physical-financial schedule, with probabilistic character.

# 4 CASE STUDY

The practical application of the developed methodology concentrated on the Lote 1 of the Trecho Norte do Rodoanel Metropolitano of São Paulo, also known as Rodoanel Mário Covas (SP-21), in São Paulo, Brazil. The extension of the Lote 1 rests in the 6,42 km, comprehend by four lanes in which direction, a tunnel with 1.155 meters, and thirteen special engineering structures and a road clover (Dersa, 2011).

The application of the proposed methodology to the present case study, took into account the need of adjustments and the definition of hypothesis, based on the information provided and publicly available, and the depth of the latter. It should be noted that the information, mentioned earlier, falls within the same time frame as the submission of the project's proposal of the proposal, by a pre-selected organization, at the end of 2012.

**Establishing the context**

In this activity, in relation to the external context, the Project Type (transport infrastructure), Project Owner (public entities), Host Country Characterization (considered as interesting for the organization, despite the identified obstacles) and Contract Type were discussed. The last

one, points to an expected date for the project's completion in a 36-month work, where it's not allowed to propose alternative deadlines to conclude the project, or to consider alternative technical proposals or solutions. In terms of monthly payment plan, payment is expected every two months after the execution of the work, and there will be no advance payments. In terms of price revision, these only occur after a year of the proposal submission, based on construction indexes. In the event of non-completion within the expected deadline (36 months), fines will be applied, with the possibility of unilateral rescission of the contract.

As regards the internal context, this stage refers to the conditions of market entry (consortium through the local subsidiary), the identification of the involved assets (where all the elements necessary for the project are provided by local companies or subcontractors, with the exception of the excavation equipment, which is rented from an American company) and the planned physical-financial schedule. In relation to the latter, the Lote 1 was divided into six core activities, in which direct costs are incurred. It has been stipulated that activity 1 runs throughout the all the project's execution, and that, in terms of sequential execution of the activities, activity 5 can only be completed after the end of activities 2, 3 and 4 and after (or at the same time) the completion of activities 1 and 6. In terms of direct, indirect and other costs, monthly payment plans were established. Thus, the organization, based on the 36 months period planned to execute the project, estimates a total value of 807012 kR$ for execute the project, and a total cost associated, with the latter, of 716546 kR$.

The planned physical-financial schedule, during the years 2013 to 2016, is replicated by the cash flow schedule and the project schedule (Figure 4.1), throughout the organization's project management.

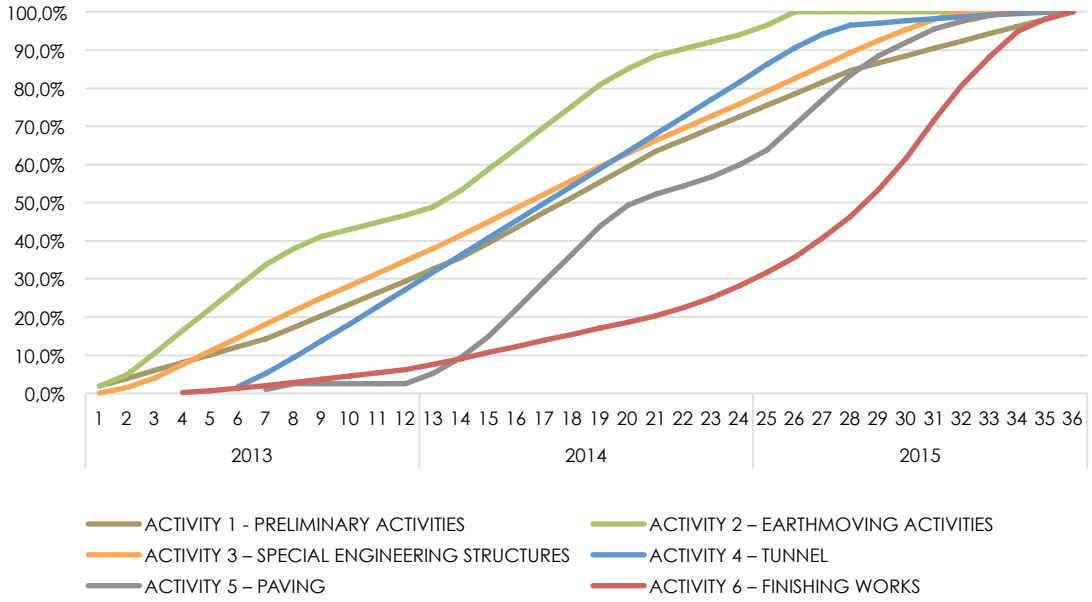


Figure 4.1 – Planned activities schedule (% by month)

## Risk Assessment – Identification

**Inherent execution risks** – The risks were identified through expert information, based on the opinion of experts with more than 20 years of professional practice. The result of the

information obtained focus, with special relevance, on three risks external to the organization and the same number in others related to the internal background. The first three concentrates on factors related to social conflicts (arising from strikes, protests and other social events), excavation activity (related to drilling and detonation stages and the geotechnical behaviour) and meteorological events (from adverse conditions), which were numbered, respectively, from 1 to 3. The risks originated from an internal source to the organization, relate to factors with the coordination of the consortium, extra/less works and errors and omissions, which were respectively numbered from 4 to 6.

**Macroeconomic risks** – Based on the opinion of experts who exercised budget estimate activities and project cost control, with direct experience with Brazil, risks related to the behaviour of the following economic indicators were identified: **Inflation Rate**, in which were used the IPC-FIPE index; **Interest Rate**, where the annualized Selic rate was used with the addition of a fixed amount, taking into account that the project's financing is supported through bank loans; **Exchange Rate**, between the Brazilian Real and the US Dollar (R$/$) (in view the need to import) and the Euro (R$/€), when converting capital gains, at the project's conclusion.

**Risk Assessment – Analysis**

**Inherent execution risks** – After selecting the risks to be analysed, they were characterized according to their likelihood, the type of impact (in duration or direct cost of each activity) and the magnitude of the impact on each activity, during the project's execution.

**Macroeconomic risks** – In order to obtain stochastic values for the economic indicators, in the project's execution period, relations were established between those indicators and the annual inflation index rate of Brazil, IPCA, based on the reports from Banco Central do Brasil (BCB, 2012) and on historical records. Relative to the IPC-FIPE, the relation was obtained statistically through linear regression, whereas for the price indexes (necessary for price revision), adjusted statistical distributions were established involving the annual difference between the indexes and IPCA. Concerned to the Selic rate, an adjusted statistical distribution was also established relating the annual difference between the aforementioned rate and IPCA. Regarding exchange rates, based on the theory of Purchasing Power Parity, certain values, designated as the real exchange rate (RER), were determined, which result from the product of the nominal exchange rate (NER) (verified in the currency exchange bureaus) and the relative price levels between countries. Thus, through the difference between the RER and NER, an adjusted statistical distribution was obtained.

**Risk Assessment – Results**

Simulation sets were implemented, using the Monte Carlo method, based on the data obtained previously. In order to provide a suitable basis for the results, 10 000 simulations

were performed in each set, where stochastic values were obtained for relevant characteristics to the project's execution. It is worth noting the 48-month consideration, which makes up the maximum deadline for the project's conclusion, considering possible delays. The combination of macroeconomic risk and the inherent execution risks impacts implies that the first cannot be dissociated from the impacts of the second. This is justifiable in view of the fact that an increased cost attributed to one of the inherent execution risks is suffered an augmentation due to the macroeconomic risks. This augmentation will depend on the impact's timeline or the relevance to the project's monthly balance. The formulation of the monthly cash out, without accounting financing costs, is provided by:

$$H_i = \begin{cases} U_i - G_i & to\ \ i \leq 36 \\ U_i - G_i - K'_i - T & to\ \ i > 36 \end{cases}$$

where "U" corresponds to cash in, "G" to direct, indirect and other costs, "K" delay related costs, and "T" to contractual costs. To these values is added the financing costs, in order to provide the total net result for the organization. In relation to the duration of the activities, this is affected by the impact of the inherent execution risks, where it was considered that each activity is a critical task in the endeavour of the project. This consideration was established due to the inexistence of information regarding the flexibility of the project's schedule, regarding each activity. Thus, a variation in the duration of an activity has a proportional repercussion in the execution schedule of the latter, depending on the sequentially and interdependence between activities.

The simulations were performed in order to obtain stochastic results for the most relevant parameters for the elaboration of the project's physical-financial schedule. Firstly, a set of simulations was carried out based on the hypotheses mentioned previously, and later a second set of simulations was elaborated within a scenario with the observed macroeconomic parameters, between the years 2013 and 2016. The results obtained in relation to the planned ones and those obtained in the two simulations, are reflected in the physical-financial schedule, composed by the Figure 4.2 and the Figure 4.3, and by the Table 4.1.

Since the inherent execution risks do not change, as to their likelihood or magnitude of impact, in the two simulations, comparisons between the same were neglected as to the impact on the activities duration. In both simulations delays were observed in the execution of the project, which had different repercussions in both simulations. In the first simulation, in spite of the delay in the overall project's deadline, the total net result for the organization, on average, shows values higher than expected. This fact results in the observation of the lower overall negative impact of the risks on the total cost of the work, as opposed to the increase in the project's value, essentially the result from price revision and extra works impacts. In the second simulation, as opposed to the first simulation, shows a higher impact due to inflation rate (higher than the first simulated IPC-FIPE values) and the lower outcome from price revision. This set of factors leads to a lower average value of the total net result than the one recorded in the first simulation. However, when converting to euros, results between simulations reverse, pointing out to the values of the second simulation, which were more

interesting for the organization, as shown in Table 4.1. This reflects a more depreciating exchange rate in the first simulation compared to the second one.

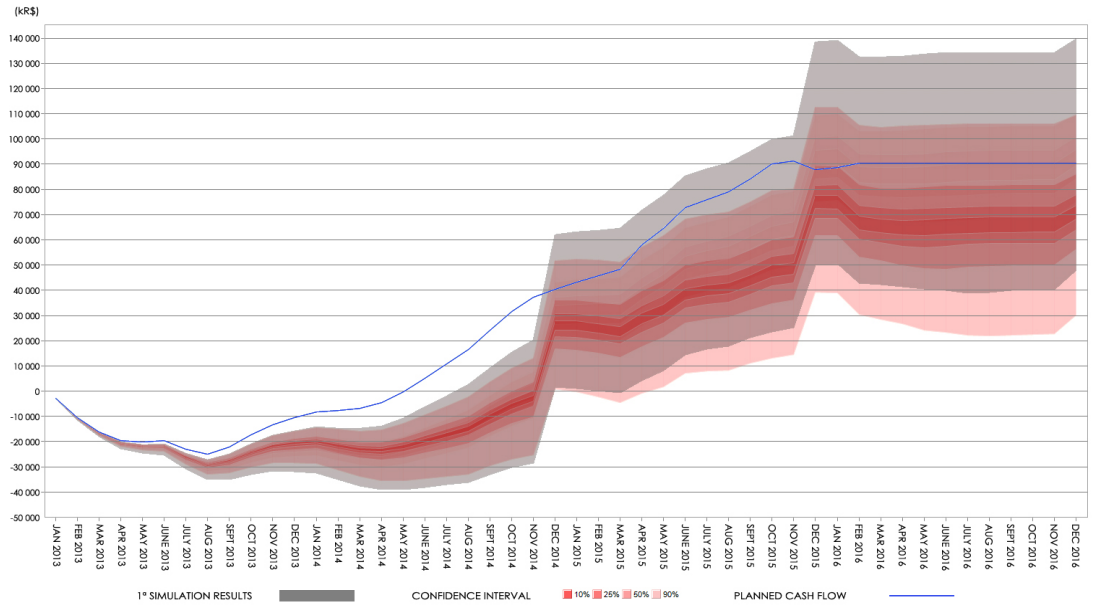


Figure 4.2 – Planned physical-financial schedule and the result from the two simulations, in kR$

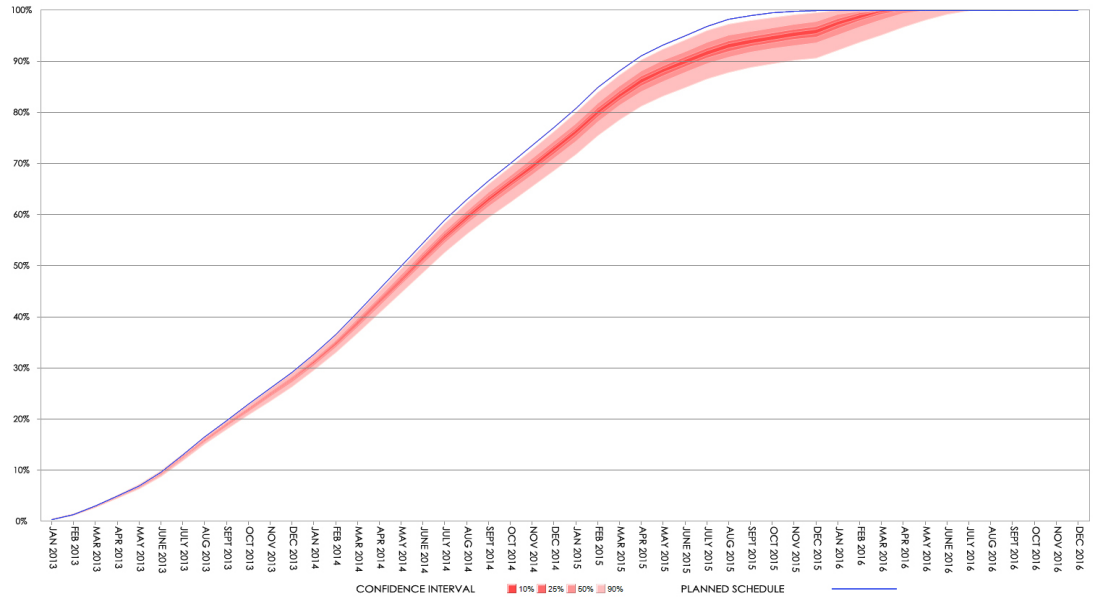


Figure 4.3 – Planned and effective project's schedule, in months

Table 4.1 – Observed values in chapter 4

| Phase | Parameter | kR$ | K€ | Months |
|---|---|---|---|---|
| **Internal Context** | **Total Net Result** | **90 466** | **33 186** | **-** |
| | **Total Duration** | **-** | **-** | **36** |
| **1ª Simulation** | **Total Net Result** | **93 253** | **17 191** | **-** |
| | **Total Duration** | **-** | **-** | **39,4** |
| **2ª Simulation** | **Total Net Result** | **71 285** | **20 780** | **-** |
| | **Total Duration** | **-** | **-** | **39,4** |

# 5 FINAL CONSIDERATIONS

The main contributions of this dissertation are, above all, conceptual, with the development of the methodology. The physical-financial schedule of the project was used, as an image of the conjectural impact of the risks, in the context of an international project, on two factors relevant to the execution: cost and duration.

The results point out to the significant relevance of the impact of the inherent execution risks both in the duration and in the cost of the enterprise. It is noted that risk 2 (excavation activity) gain relevance above the remain, mainly due to the magnitude of the impact and the influence on activity 4 (tunnel), which has a relevant preponderance over the overall project duration and cost. Due to this fact, the importance of the inherent execution risks could have a different impact on an enterprise with different characteristics. As for macroeconomic risks, the magnitude of their impact depends not only on their intrinsic parameters, but also on the impact of the inherent execution risks, having an amplifying effect on the impacts of the previous. It was therefore relevant to understand the relationship and combination between the risks of these two categories, in order to obtain more accurate results. Within the category of macroeconomic risks, the values, obtained in the simulations, points out a lower relevance, on the project's overall net result, by the impacts of the risks related to the variation of the interest rate and exchange rate. However, it is understandable that this observation is only relevant to the context of this case study.

It may be concluded, in spite of the subjective context of the case study, that the risks assessed strongly affect the viability of the undertaking project in question. This conditioning enhances the relevance of using accumulated experience and historical records to validate risk analyses in a stochastic way, in case of the inherent execution risks, and the importance of ensuring a better reliability and understanding of the macroeconomic parameters in the construction context. It is also added that, considering the possibility of manipulating more variables related to the project's execution, such as the variation in the activities schedule or in the cash in/out schedule, an optimized physical-financial schedule could be elaborated according to the interests of the organization concerned. This optimization gains an added importance when it is applied both in the planning phase (or in the selection phase between

potential candidate projects, by the organization), as well as throughout the execution of the project, validating the adequacy of initially established hypotheses, as well as identifying possible evolutions, changes and new occurrences related to the risks both in the internal and external context to the organization. Thus, in view of a real context, of simultaneous execution of several projects, the use of this methodology by an organization may constitute a tool not only to perceive the viability of the project in question, but also the organization itself.

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