

FIDIC contracts: analysis of the impact of general and particular conditions on the financial risk management in Romanian infrastructure projects¹

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Abstract

Construction projects are characterized by risks and uncertainties mainly due to technical and economic complexity. Risk management is an important tool in making decisions involving the identification and reduction, avoidance or transfer risk and uncertainties consequences of events that occurs during project implementation. For this reason, the objective of the contract between the beneficiary and the contractor is the allocation of risk. The distribution of risk in contracts for the execution of construction works was and is an ongoing challenge faced by parties having a significant impact on the type of contract is used. On the one hand, the beneficiaries tend to transfer to the contractors as many of the project risks and uncertainties, on the other hand, the contractors look to exploit any weakness contract, so as to reduce their impact on the expected profit. One of the most important risks assumed by the contractor by signing the contract which is also increasingly common in the current economic situation is the reduced financial capacity to support the project. A purely legal or purely technical interpretation is not meant to describe the complexity of issues related to implementation of construction projects. For this reason the authors have adopted a multi-disciplinary approach, which includes the legal issues related to the nature of the contract, but also the financial and technical aspects of construction projects. The paper aims to analyze how special contract clauses can influence the implementation of construction projects and in particular the financial management of contractors. The authors propose a model for analyzing the impact of FIDIC contract conditions applied on a case study of five transport infrastructure projects.

Keywords: risk, contract, FIDIC, time, cost.

JEL Classification: K12, K23

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1. Introduction

Construction projects are characterized by a high level of risk and uncertainty, due to their complexity. Risk management is an important tool in making decisions involving the identification and reduction, avoidance or transfer risk and uncertainties consequences of events that occurs during project implementation. For this reason, the objective of the contract between the beneficiary and the contractor is the allocation of risk.

The distribution of risk in contracts for the execution of construction works was and is an ongoing challenge faced by the contracting parties having a significant impact on the type of contract that will be used. On the one hand, the beneficiaries tend to transfer to the contractors as many of the project risks and uncertainties, on the other hand, contractors look to exploit any weakness contract, so as to reduce their impact on the expected profit.

Projects risks can be classified on the basis of two factors: natural risks and hazards due to human factor. Natural risks may be due to exceptional adverse weather conditions, unpredictable forces of nature and unforeseeable physical conditions. Risks due to human factor causes are determined, above all, the main actors involved in the contract (employer, contractor, engineer or third parties), the social or political events, economic dynamics and regulatory changes.

The authors analyze risks and contractual clauses 8:14 influence of FIDIC contract conditions on the financial relationship between the beneficiary and entrepreneur focusing on the effects of special conditions have on the financial management of the contractor. Continuing a series of previous work^{4, 5, 6, 7}, the authors propose a practical approach to quantify risk by defining a model for analyzing the impact FIDIC contract conditions, which is applied in a case study of five transport infrastructure projects.

2. FIDIC Conditions of Contract

The adoption of FIDIC contract conditions in infrastructure projects is widely accepted around the world, being recommended or required in international agreements mainly by the financing banks. These conditions were tested more than 50 years, they are flexible, reflect the market requirements and distribute balanced the risks, rights and obligations of the parties by the terms contained therein.

⁴ Purnus, A., Bodea, C. N. (2015). *Financial management of the construction projects: a proposed cash flow analysis model at project portfolio level*, „Organization, Technology & Management in Construction: An international Journal”, Volume 7, Issue 1, 2015, pp. 1217-1227, http://www.grad.hr/otmcj/clanci/vol%207_1/OTMC_6.pdf (accessed 30 August 2016).

⁵ Purnus, A., Bodea, C. N. (2014). *Correlation between Time and Cost in a Quantitative Risk Analysis of Construction Projects*, „Procedia Engineering”, Elsevier Ltd, vol. 85, 436-445.

⁶ Purnus, A., Bodea, C. N. (2016). *Influența condițiilor de contract FIDIC asupra managementului financiar al proiectelor de construcții*, „Revista Română de Inginerie Civilă”, Vol. 7 (2016), No. 1.

⁷ Sararu, C.-S. (2014). *The interpretation of administrative contracts*, „Juridical Tribune – Tribuna Juridica”, Volume 4, Issue 1, June 2014, pp. 152-156.

Representing the most popular form of contractual relationship in the case of infrastructure projects, FIDIC contract conditions^{8, 9} are characterized by their fairness in risk distribution. Since inception phase of the project, the beneficiaries analyze risks and determine the form of contract that fits best to the level of risks. Thus, when you choose Red Book, the beneficiary take the risks related to the contract price, considering that the activities are measurable quantities of efforts. When you decide to adopt the Yellow Book you avoid the risk of the contract price, but you may lose control over quality. Some risks are shared, such as legislative changes or price changes, while aspects of the obligations and responsibilities of the parties become potential risk events.

The harmonization of FIDIC contract general conditions with the law in force and the particular project is done through special conditions of contract. Although FIDIC has provided a guide for drafting special conditions so that the parties may not alter the equitable sharing of risks, most often the beneficiaries, on the basis of priority public interest, make significant changes of general terms, thus transferring most of the risks to the contractor, which frequently leads to situations where projects are delayed and over the budget that was originally set. One of the most important risks assumed by the contractor by signing the contract which is also increasingly common in the current economic situation is the financial capacity to support the project.

A purely legal or purely technical interpretation is not meant to describe the complexity of issues related to implementation of construction projects. For this reason, the authors have adopted a multi-disciplinary approach, in order to include not only the legal aspects, of the nature of the contract, but also the financial and technical execution of construction projects. The paper aims to analyze how special contract clauses can influence the implementation of the construction projects and in particular the financial management made by contractors.

3. The application of FIDIC Conditions of Contract in infrastructure project in Romania

Current economic conditions of construction projects implementation are characterized by a significant reduction of public investment, linked to an increase of the aggressive competition, especially in the construction market. Despite government efforts to use all financial resources, especially European funds, for the development and completion of transport infrastructure projects, most of them are delayed and over budget. European Commission¹⁰ criticized Romania's limited

⁸ FIDIC 1999, Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer, International Federation of Consulting Engineers (FIDIC), First Edition, 1999, (Romanian version)

⁹ FIDIC, 1999, Conditions of Contract for Plant and Design-Build for Electrical and Mechanical Plant and for Buildings and Engineering Works Designed by the Contractor, International Federation of Consulting Engineers (FIDIC), First Edition, 1999, (Romanian version)

¹⁰ European Commission, Country Report Romania 2016, Brussels, 26.2.2016, SWD (2016) 91 final, p. 41, http://ec.europa.eu/Europe2020/pdf/csr2016/cr2016_romania_en.pdf, (accessed 30 August 2016)

capacity to absorb EU funds due to insufficient preparation of projects and the influence of external factors. Less than 70% of European funds were used in the period 2007-2014 and many projects await to be funded through 2015 - 2020 European Programs. Major European investment funds from the public budget or involved in transport infrastructure projects require the use of balanced, accepted and tested contracts. These characteristics are achieved by FIDIC conditions of contract. FIDIC contract is the main type of contract used in transport infrastructure projects in Romania. However, due to high competition, construction companies are forced to participate in biddings with low prices and to accept excessive risk and becoming financially very vulnerable. In the latest annual report, the FIDIC President¹¹ noted that, in recent years, contract conditions have deteriorated, some firms accepting unfair contract terms.

In its report¹² of June 2015, the National Company of Motorways and National Roads in Romania presented the status of 28 transport infrastructure projects underway. Of these 18% were terminated and 32% had extensions of time from 6 to 23 months (Figure 1).

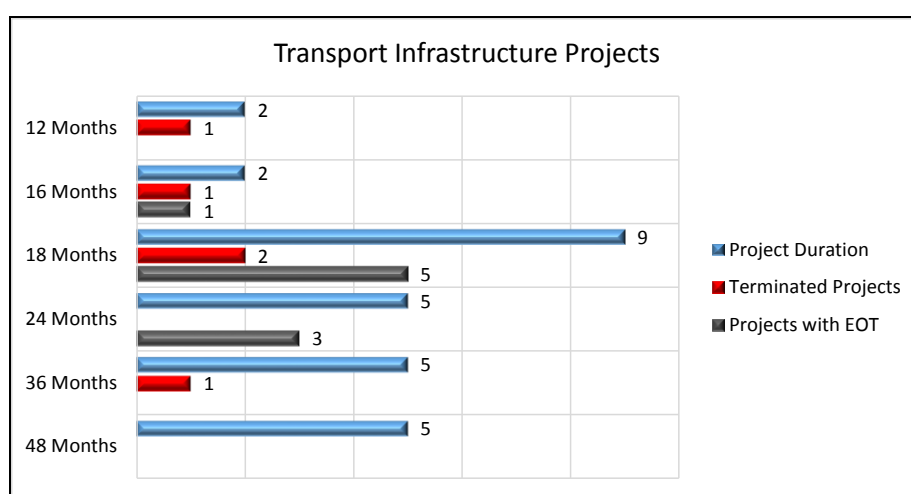


Figure 1

¹¹ FIDIC (2015a). Annual report 2014-2015, available at: http://fidic.org/Annual_Report “...Unreasonable price competition in the awarding of engineering services is more frequent today than ever before. As a result, this situation brings inefficient investment in infrastructure development. Many decision makers are creating less efficient systems which do not help to improve the quality of life today and in the future. These are causing higher costs of construction and operation, delays in delivery, increased risk-taking, and a less efficient response from the developers of infrastructure to the real needs of social communities. ...The conditions of our contracts have also deteriorated in recent years. Some firms are wrongly accepting abusive contract conditions, unlimited liabilities, on demand performance bonds, undefined scopes of works in lump sum contracts, and other unfair demands, and this is contributing to the deterioration of our profession.” (pag. 45).

¹² CNADNR, Stage Projects underway, www.cnadnr.ro/sites/default/files/ (accessed 18 August 2015).

More than 60% of the projects had a physical progress of less than 30%, the least likely to be completed by 2015, while in terms of financial progress, most of them were facing lack of financial resources (Figure 2).

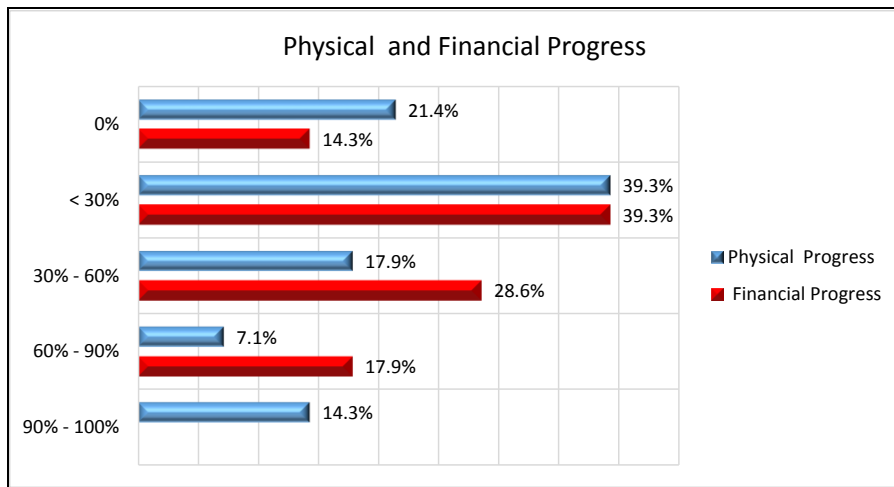


Figure 2

Even if the projects were relatively well supported with financial resources by the employer, contractors have submitted a large number of claims. The three main reasons for claims of contractors (73% of the total), are: lack of permits or delays in ensuring the access to the site and expropriation delays and variation orders (Figure 3).

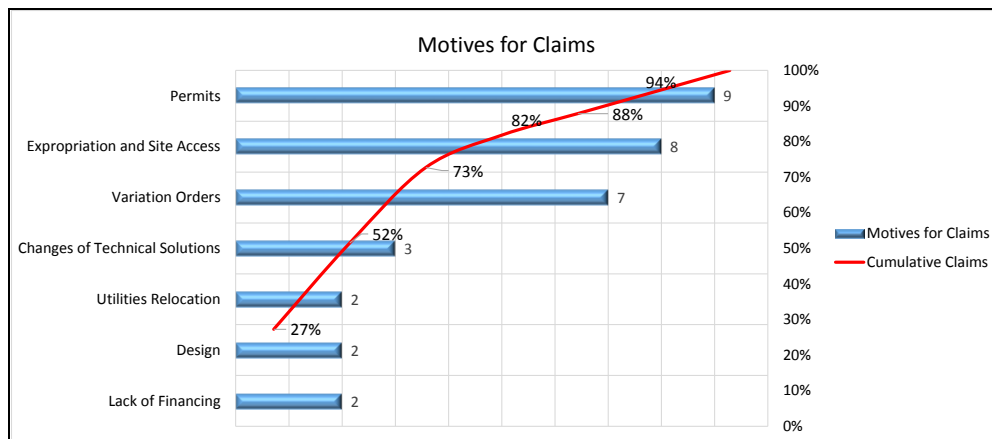


Figure 3

The lack of effectiveness in the implementation of several transport infrastructure projects is explained by the influence of various economic and social factors, including cost and time constraints imposed to contractors by FIDIC

contract conditions. It has become common practice to consider construction contracts not only from a legal perspective, but also as a tool for financial management of construction projects^{13, 14}.

The report¹⁵ published in March 2016 presents the aggregate value of the ongoing arbitrations before the International Court of Arbitration in Paris, all initiated against CNADNR by contractors or consultants. 32 actions that have asked for abroad court of arbitration have a total value of over 360 mil. Euro, representing payments and unpaid bills by CNADNR, financial discrepancies or non-implemented decisions. Analyzing the distribution of claimed values (Figure 4) we can see that over 80% of them exceed 5 mil. Euros.

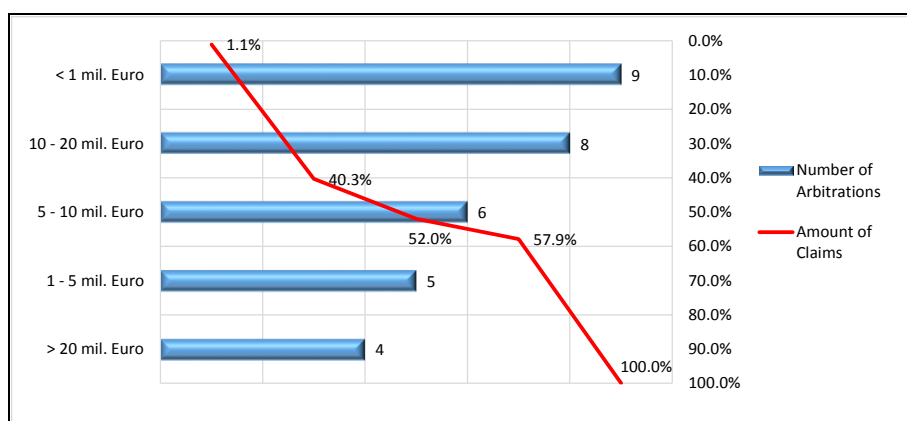


Figure 4

Analysis of the impact of FIDIC contract conditions on the project financial management for transport infrastructure sector is very relevant, taking into account that the Minister of Transport Order no. 146/2011¹⁶ requires the application of FIDIC conditions (especially red and yellow Books) by all subordinate agencies under the Ministry of Transport for transport infrastructure works of national importance with public funds and contracts whose value exceeds a certain amount. But the first attempt to impose FIDIC standard forms in Romania

¹³ Bănică, C. (2013), *Standard forms of construction contracts in Romania*, „Urbanism. Arhitectură. Construcții”, vol. 4, no. 4.

¹⁴ Zimmermann, J., Eber, W. (2014). Development of key performance indicators for organizational structures in construction and real estate management, Proceedings of the Creative Construction Conference, 21-24 June, 2014, Prague.

¹⁵ <http://www.tirmagazin.ro/index.php/din-presa/13-esential/esential/15789-cnadnr-poate-pierde-un-sfert-din-bugetul-anual-in-INSTANTA#!comment>, accessed on 15 June 2016.

¹⁶ Official Gazette no. 188 of March 17, 2011, Order no. 146 of 1 March 2011 approving the special contractual conditions of contracts for equipment and construction, including design and contracts for construction of buildings and engineering works designed by the beneficiary of the International Federation of Consulting Engineers in construction (FIDIC) to investment objectives in the field of road transport infrastructure of national interest, publicly funded, Issuer: Ministry of transport.

is the common Order of the Ministry of Transport, Finance and Public Works no. 915/2008¹⁷, but its implementation was halted in 2009 due to contradictions arising from the superficial translation and inconsistencies with the legal framework and regulations for the period¹⁸.

Another important cause for the difficulties of contractors during project execution is the extremely low offer prices at biddings. Award of construction projects based on the criterion "lowest price" leads very often to situations where projects are awarded at 50% of the reference value. The effects on the construction industry of such practices are extremely harmful. On short term, contractors will be unable to carry out the construction works due to low prices at tender stage. Also, the quality of work could be significantly reduced. On long term, these practices lead to insolvency and then bankruptcy.

The authors of the paper analyze the influence of Clause 8 and Clause 14 of FIDIC conditions of contract to the financial relationship between employer and contractor and their effects on the contractor's financial management. Continuing a series of previous work^{19, 20}, the authors propose a practical approach to quantify risk by defining a model for analyzing the impact of FIDIC contract conditions, applied on a case study of five transport infrastructure projects.

4. Treatment of time and cost in FIDIC conditions of contract

Two main aspects define any contract: time and cost. The FIDIC conditions of contract describes the aspects that govern the relationship between the employer and the contractor within two clauses^{21, 22}: Clause 8 "Commencement, Delays and Suspension Works" and Clause 14 "Contract Price and Payment".

In Clause 8 are detailed the commencement of work, time for completion, the time program, the conditions contractor will be entitled to an extension of time for completion, delays caused by authorities, the rate of progress, delay damages,

¹⁷ Order no. 915/465/415 of 25 March 2008 approving the general and special contractual conditions to completion of works, Issuer: Ministry of Finance, published in the Official Gazette NO. 424 of 5 June 2008.

¹⁸ Georgescu D. (2011), *Considerations concerning the applying of FIDIC contracts in Romania*, „Bulletin of the Polytechnic Institute of Iasi - Construction & Architecture”, 61(2): 29-40.

¹⁹ Purnus, A., Bodea, C. N. (2015). *Financial management of the construction projects: a proposed cash flow analysis model at project portfolio level*, „Organization, Technology & Management in Construction: An international Journal”, Volume 7, Issue 1, 2015, pp. 1217-1227, http://www.grad.hr/otmcj/clanci/vol%207_1/OTMC_6.pdf.

²⁰ Purnus, A., Bodea, C. N. (2014). *Correlation between Time and Cost in a Quantitative Risk Analysis of Construction Projects*, „Procedia Engineering”, Elsevier Ltd, vol. 85, 436-445.

²¹ FIDIC 1999, Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer, International Federation of Consulting Engineers (FIDIC), First Edition, 1999, (Romanian version) p. 29 and p. 45.

²² FIDIC, 1999, Conditions of Contract for Plant and Design-Build for Electrical and Mechanical Plant and for Buildings and Engineering Works Designed by the Contractor, International Federation of Consulting Engineers (FIDIC), First Edition, 1999, (Romanian version) p. 30 and p. 47.

the suspension of work and its consequence, payments in event of suspension, prolonged suspension and resumption of work.

Clause 14 details the contract price, the advance payment, application for interim payment certificates, the schedule of payment, how will be made the payment, the delayed payment and payment of retention money, the statement at completion and the final payment certificate.

FIDIC Red Book “Conditions of Contract for Construction of buildings and engineering works designed by the employer” - General Conditions²³ defines the sequence of typical events of payments (Figure 5): at the end of each month or the reporting period, the Contractor submit the Statement and the supporting documents to the Engineer. After its verification, if the Statement is accepted, the Engineer will issue in maximum 28 days the Interim Payment Certificate. The Employer shall pay to the Contractor the amount certified within 56 days after the Engineer receives the Statement and supporting documents. The Employer will make the final payment within 56 days after the Engineer issue the Final Payment Certificate.

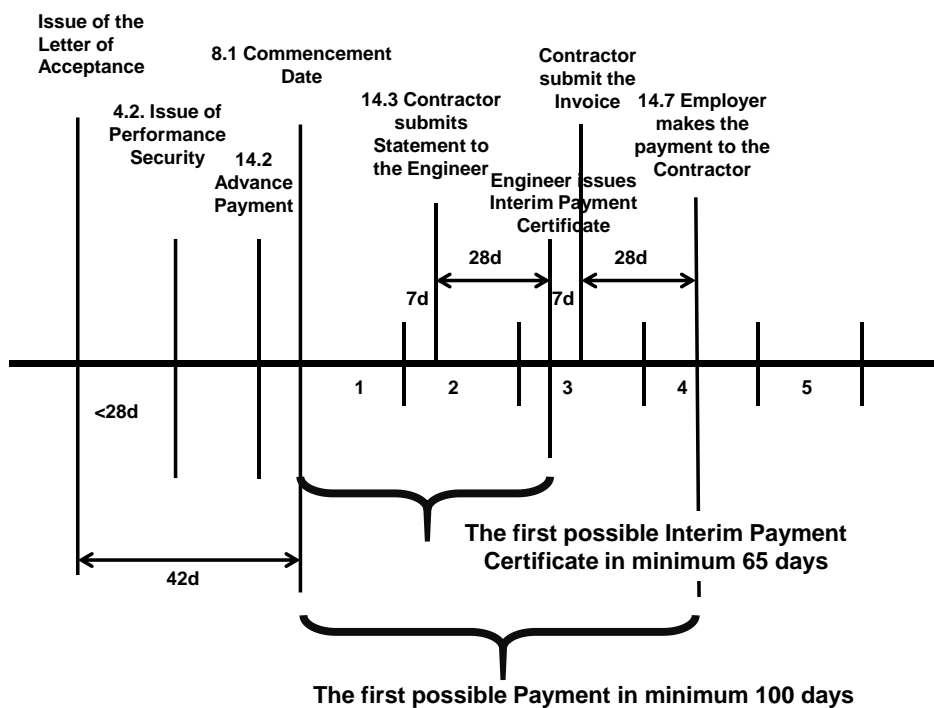


Figure 5

²³ FIDIC 1999, Conditions of Contract for Construction for Building and Engineering Works Designed by the Employer, International Federation of Consulting Engineers (FIDIC), First Edition, 1999.

If we take into consideration that the minimum time needed by the Contractor to prepare the Statement and supporting documents is 7 to 10 days, the first Interim Payment Certificate (IPC) will be issue at 65 days after the Date of Commencement. Considering that issuing the invoice by the Contractor is 7 days, the first payment will be done in 100 days after the Date of Commencement. With such constraints, the contractors will face a huge financial pressure in order to sustain the progress of works according with their programs.

5. Impact Analysis of FIDIC contract conditions on the financial management of projects

Due to the adverse economic conditions, the contractor decisions are based taking into account his financial capacity to support the project, in direct relation with the incomes. The proposed model consider that different type of construction projects lead to specific shape patterns of the contract price distributed on time. The objective of the analysis is, first, to quantify the contractor's potential financial effort due to the variation of several parameters: project duration, the date of commencement, the time interval for the invoice payment and the date of issuing of the Statement and supporting documents. Secondly, the analysis aims to calculate the probability corresponding to a reasonable financial effort to support the project and its execution in optimal conditions.

Five real projects of transport construction, based on FIDIC Red Book Contract - General Clauses were analyzed. The first project represents the consolidation of a section of national road length of 7.200 Km, the second project aimed the construction of a by-pass (7.625 km in length), third one dealt with the rehabilitation of a section of national road length of 38.27 Km, the fourth project is the rehabilitation of a national road of 88.460 km and the fifth project is the construction of a section of high way (19.650 km in length). There were developed and analyzed a total of 270 different cash flow templates. The typical contract price monthly distribution, payments and cash flow is presented in in Figure 6.

The following computation hypotheses were considered in the cash flow analyze:

- The payments will be made considering only the General Conditions of Contract;
- The effect of the advance payment and the guaranty for the advance payment was not taken into account;

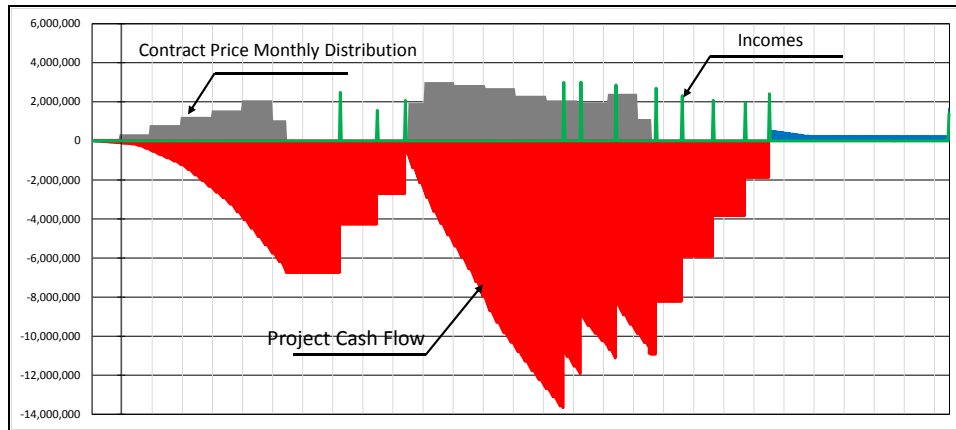


Figure 6

- The depreciation, the bank taxes and bank charges were not taken into account;
- The Statement and supporting documents are prepared by the Contractor monthly, or for minimum 5% from the Contract Price.

According to the contractual terms, the project's cash flow consists of the following categories of contractor costs: costs of labor, materials, equipment and transport, other direct costs, overheads, profit and incomes. In the cash flow analysis, the following parameters' variation were taken into account:

- Construction project duration considering for one project the following durations: 16, 18, 20, 22 and 24 months;
- The date of commencement; the project schedule was developed so that the date of commencement of work corresponds to the months from March to October;
- The time interval for the invoice payment considering the following payment terms: at 30 days, at 60 days and 90 days;
- The date of issuing of the Statement and supporting documents. Two cases were considered for the date of issuing the Statement: at 10 days and at 35 days after the reporting period.

In each scenario analysis it was determined the maximum amount of cash flow and its share in the contract price and as a result, the financial effort that the contractor has to support in order to carry out the work within the parameters contracted, identifying the most favorable and unfavorable situations for each type of project.

The effect of project duration

For the study we examined the influence of the length of the project 1 - the consolidation of a national road section 7,200 km, taking into account the variation of its duration between 16 and 24 months. Cash flow was obtained under conditions where that paying bills is 30, 60 and 90 days and the Statement and supporting documents are issued at 35 days after the reporting period. Considering that the date of commencement varies from March to October, there were retained the maximum and minimum weights of the peak of cash flow. As a result, we

obtained the variation of peak share of cash flow from the contract price variation considering the duration of the project (Figure 7).

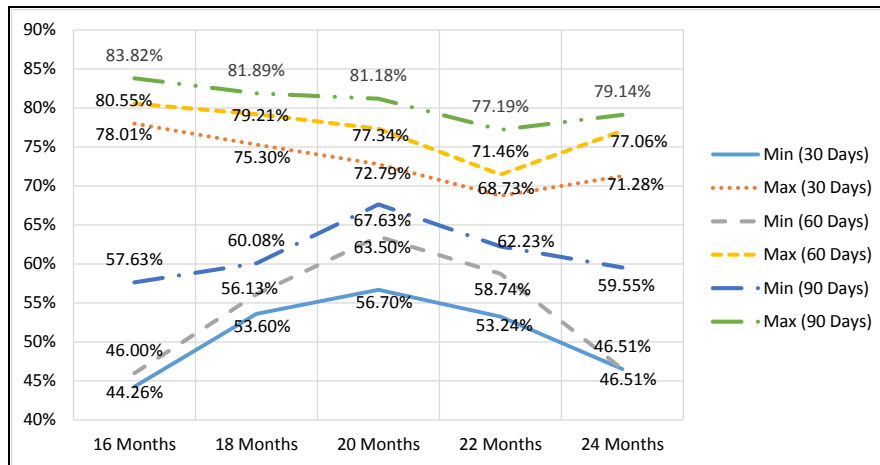


Figure 7

Analyzing the results, we can find that for this type of construction project, the minimum weight of cash flow peak is obtained for 24 months duration, due to the distribution of the contract price on a higher duration. For this duration, the cash flow peak weight from the contract price varies from 46.5% to 79% depending on the date of commencement and the interval for payment. The contractor financial effort will be as higher as the delay of payment will be higher.

The date of commencement effect

In order to emphasize the influence of the date of commencement on the contractor financial support, several hypotheses were taken into consideration:

- All five projects have the duration of 24 months;
- The Statements and the supporting documents are prepared and submitted at 35 days after the end of the reporting period;
- The payments are made at 30, 60 and 90 days.

In the case of project 1 - the consolidation of a section of 7.200 km of a national road, the cash flow peak weight from the contract price vary from 39.20% to 63.20% of the contract price, depending the date of commencement and the interval for payment (Figure 8). Optimal date of commencement of the project is in April and May. Starting the project in all other months lead to a big contractor’s financial effort.

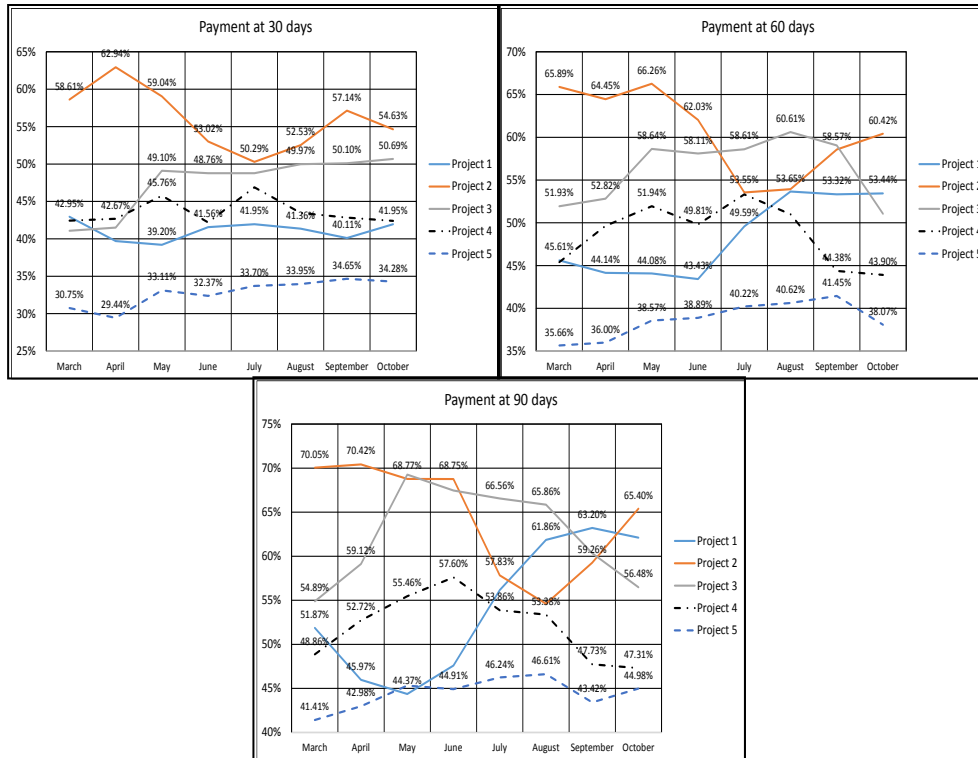


Figure 8

For the project 2 - the construction of a by-pass of 7.625 km, the cash flow peak weight from the contract price vary from 50.29% to 70.42% of the contract price, depending the date of commencement and the interval for payment. Optimal months for commencement of the project are July and August, while April is not recommended for starting the project.

In the case of project 3 - rehabilitation of a section of national road in length of 38.270 Km the cash flow peak weight from the contract price vary from 41.08% to 69.26% of the contract price, depending the date of commencement and the interval for payment. The best time to start work is in March and April.

The fourth project 4 - the rehabilitation of a national road of 88.460 km, is characterized by a change in shares peak cash flow between 42.19% and 57.60% of the contract price, depending the date of commencement and the interval for payment. Optimal starting date of the project is in September and October.

In the case of project 5 - construction of a high way section of 19,650 Km, the cash flow peak weight from the contract price vary from 29.44% to 46.61% of the contract price, depending the date of commencement and the interval for payment. Optimum project start date is in March and April.

The effect of the time period for paying bills

The effect of the time period for paying bills manifests on all the analyzed situations. Considering the same set of conditions, the contractor’s financial burden varies when paying bills is 30 days between 34.65% and 63%, 41% and 66% when paying bills is 60 days and between 46% and 70% when paying bills is 90 days, depending on the project type and project date of commencement (Figure 9).

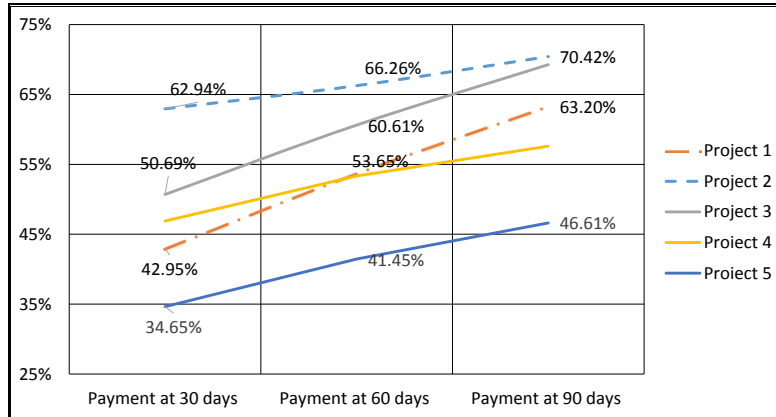


Figure 9

As a general conclusion on this issue, we can say that as the time for paying bills becomes greater, the contractor’s financial effort becomes larger.

The effect of timeframe for issuing work situations

Although the preparation and issue of the statement and supporting documents by contractors in the shortest time is in their interest, practice shows that most often, they are not enough well organized and prepared for drafting the necessary documents.

Issuing as early as the statement and supporting documents can reduce the contractor’s financial burden between 2% and 12.78% for project 1 between 3.2% and 9.07% for project 2 and between 6.72% and 10.65% for the project 3 taking into account the project start date and time for paying bills (Figure 10).

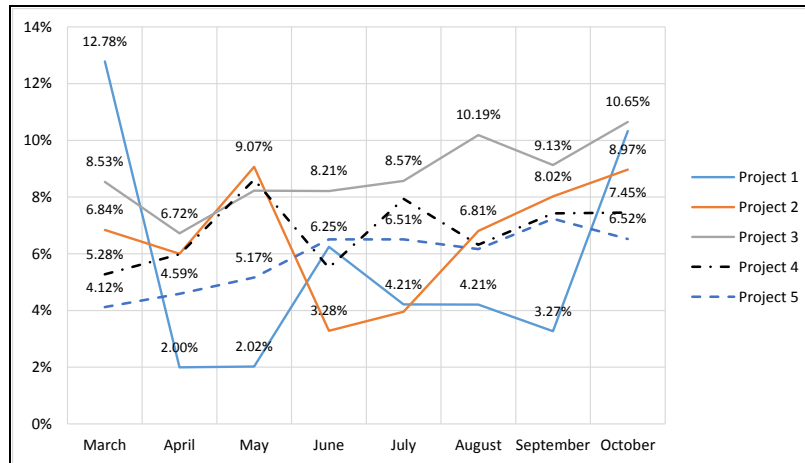


Figure 10

In the case of the project 4, the financial burden may be reduce between 5.28% and 8.61%, and in the case of project 5, between 4.12% and 7.24% depending on the start date of the projects and timeframe for paying bills.

6. Risk probabilistic approach

The deterministic, traditional approach, of the projects due to increasingly more evident risks and uncertainties requires the application of methods and techniques that take into account the events dynamics in the development of infrastructure construction. Given that the financial effort of the contractor proves to be significant, it is important to consider what share of peak cash flow from the contract price for a reasonable likelihood. Considering the effects due by the project duration, the timing for starting the work, the time for paying bills and, not least, when issuing statements of work, the analysis model proposed to apply the Monte Carlo method, considering potential event risk and uncertainty. Monte Carlo method is a risk simulation tool that allows the quantification of the risks and uncertainties, which is extremely helpful in making decisions.

For this purpose, was analyzed project 3 - rehabilitation of a section of national road length of 38 270 km, considering the following scenarios: optimistic scenario to a situation where the starting date of the works is in March, payment bills is 30 days, and works statements are issued 10 days after the end of the reporting period; the most likely scenario corresponds to the case where the starting date of the works is in April, paying bills is 30 days, and works statements are issued 35 days after the end of the reporting period; pessimistic scenario to a situation where the starting date of the works is in August, paying the bills is 90 days and work situations are issued 35 days after the end of the reporting period.

The value of cash flow peak is 9.061 mil. Euro in the optimistic scenario, 11.555 mil. Euro for the most likely scenario and 18.335 mil. Euro for the pessimistic scenario.

Applying Monte Carlo method we obtained that, for a reasonable probability of 75%, the peak cash flow should not exceed the amount of 12.0 mil. Euro (Figure 11).

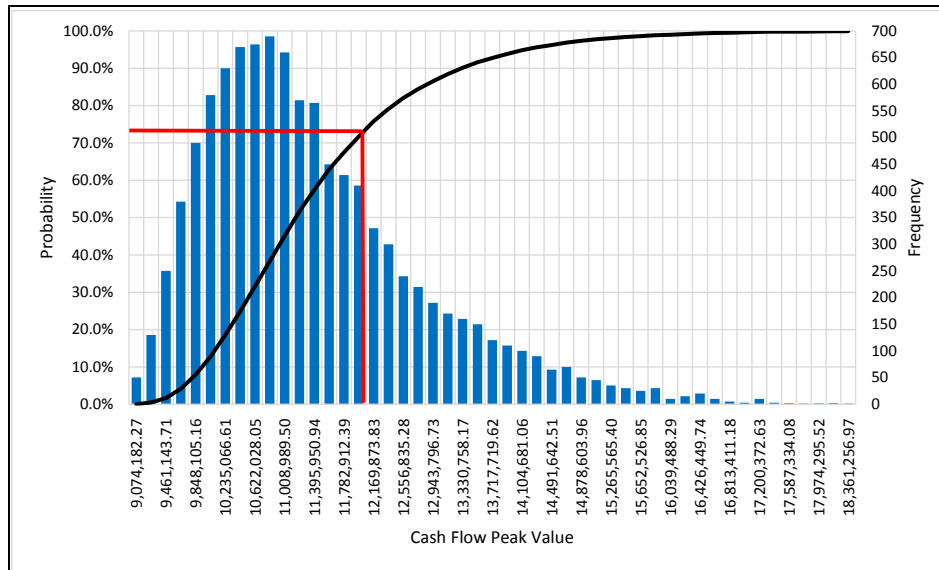


Figure 11

In these circumstances, to make sure the project will be supported from a financial perspective and that the risks arising from the terms of the contract FIDIC can be treated properly, the contractor must have that amount of money to cover peak cash flow.

7. Conclusions

The results of this study suggest that the way Clause 8 and Clause 14 from FIDIC General Conditions of contract are amended by the employer may have significant effects on the contractor strategy to supply the financial resources. The large size of the transport infrastructure projects requires a great financial effort of the contractor in order to complete the works within the parameters of time, cost and quality. Unfortunately, the experience of recent years shows that many construction companies recorded a fragile liquidity situation, very exposed to adverse shocks²⁴.

The analysis also suggests that there are a number of factors that can influence decisions, both in the bid-tender stage, but especially during the execution of infrastructure projects. These factors must be considered carefully by

²⁴ Guda, I. (2015), „Analiza sectoriala: Lucrări de construcții ale drumurilor si autostrăzilor”, Coface Romania, available at: <http://www.coface.ro/Stiri-Publicatii/Publicatii/Analiza-sectoriala-Lucrari-de-constructii-ale-drumurilor-si-autostrazilor> (accessed 10 June 2016).

construction companies. The complexity and specificity of works and applied technologies, the sequence of activities and resources involved, all are influencing the contract price distribution and lead to significant changes in the share of cash flow in the contract price. Construction companies must treat very seriously FIDIC Conditions of Contract from the stage bid-tender, so, considering the duration of the project start date thereof, the time for paying bills and the time needed to develop and issue work situations correlated with the ability of financial support, to take the most appropriate decision.

In order to analyze and understand the dynamics of the financial problems faced by contractors after signing the contract, there were considered ideal and homogeneous conditions. Describing more accurately the real processes, however, require consideration of risks and uncertainties. The presented analysis propose a model to quantify the financial risks of the contractor, taking into account the projects duration , date of commencement of work, the time for paying bills and the time required to prepare and issue work situations.

The analysis model integrates the way of defining scenarios (parameters, lists / ranges of values associated indicators, scenario analysis, how the results are presented and sequence of stages of analysis, starting with the deterministic, followed by probabilistic analysis. This model is presented using the case study, consisting of five transport infrastructure projects. The approach adopted by the authors is multi-disciplinary, since it is based both on the use of technical parameters, as well as economic and financial indicators, all in the context of contractual mechanisms for the execution of construction works. As future research, the authors propose to formalize the proposed analysis model to develop a software package that facilitates the adoption of this model by construction companies.

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