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Identification of Importance Levels of Market Risks in the Construction Sector

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Abstract: Due to the economic crisis, the Brazilian construction companies faced the challenge of remaining competitive in the market, therefore they need to be restructured. Construction projects are intrinsically risky because it changes the environment both physically and socially. Given this complexity and the great exposure to risk, this research aims to evaluate the market risks in construction projects through a field research, analyzing the perception and judgment of professionals in the area. The data analysis was performed by a multivariate index based on the statistical technique Factor Analysis that can be ordered by risk factors by degree of importance. It was possible to confirm the degree of correlation between the subgroups of risk factors and to establish a ranking of the degree of their importance, and the first one considered more relevant was the risk of reducing the quality of the workforce. It was also identified the low maturity in risk management in organizations, even though in civil works a thorough risk analysis is required.

Keywords: Market risk, construction, factor analysis.

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1. Introduction

In Brazil, Teixeira and Carvalho (2005) pointed to construction as a key sector, with strong total impacts on the national economy, proving its relevant role as a promoter of dynamic development. Construction has importance as a great generator of added value, formation of fixed capital and employment. In addition to the effects of productive linkage and significant stimulus to national product growth and job creation, its final products and services increase economic infrastructure, promoting permanent benefits over systemic productivity and the pattern of social welfare. Therefore, it is a sector that qualifies as a powerful instrument of governmental policies and that should be considered as a priority in public decisions and programs of sustained and dynamic development (Teixeira and Carvalho, 2010).

Despite this, according to the Brazilian Institute of Geography and Statistics (IBGE, 2017), there was a decrease of 2.3% of Brazilian GDP and 5.5% in construction activity in the first quarter of 2017. The largest Brazil were unable to close a single contract during the course of 2015 and the result was more than 500,000 jobs cut in the construction sector and 253 construction companies undergoing judicial recovery (Pereira, 2015).

This has led to a change in behavior on the part of firms as well as customers, as demand reduction increases the level of competition among firms in the construction sector. In this way, the builders are looking to identify their bottlenecks and increase efficiency in order to become more competitive and attractive to the customer by reducing their costs, ensuring deadlines and quality. Faced with an increasingly competitive market, companies should not only be efficient, but should become more competitive and seek effectiveness from the following perspective: commercial-financial efficiency linked to technical-economic efficiency (Araújo and Mutti, 2005).

This requires a consistent structuring of the company and continuous risk management in the execution of construction projects, as companies depend on these projects to obtain their results (Zhao et al., 2014).

To Nascimento (2003), in order for a company to reach high levels in the constant competition of markets, it is sometimes necessary to take some risks, but in a calculated way. These previously identified and controlled risks can prevent possible errors and even contribute to changes, such as improvements in initial project planning.

According to Silva (2010), the construction is a sector that presents singularities and characteristics different from the other industries. The author identifies a project as being unique to each project, making the probability of occurrence of unwanted events enormous, for reasons of project failure, weather, poor quality of labor, lack of equipment or even geological. Therefore, the construction industry is no exception to be exposed to these uncertainties, which are complex and diverse risks (Zhao et al., 2013).

Thuyet et al. (2007) pointed out that risks in construction often cause excessive time and cost. Many projects delay or exceed budgets because managers can not manage risk effectively. According to the authors, current projects are considerably more exposed to risks and uncertainties because of factors such as complexity in planning and design, presence of various stakeholders (investors, consultants, suppliers, etc.), availability of resources (materials, equipment, funds, etc.), climate, social concerns, as well as legal, economic, and political factors.

Serpell et al. (2015) argued that one of the challenges to be faced is how to measure a contractor's ability to effectively manage risk and how to help this organization improve over time. This unpredictability, as well as the complexity of the projects and the increasing requirement of the clients make it essential to study and analyze the risks (Silva, 2012).

Through a quantitative approach, Hastak and Shaked (2000) analyzed the market risks related to investment in construction at international levels, considering the variations in market characteristics and the project management system adopted. In addition, Bu-Qammaz et al (2009) dealt with market risk factors related to international construction projects, focusing on the analysis of clients, contractual conditions and the maturity of the local legal system. However, their model does not establish a hierarchy by degree of relevance to the professionals of the area, besides not covering other risks factors. Furthermore, the perception of risk changes in the face of the country's economy and politics. As reported by Lobato et al (2012) the current business environment experiences increasingly unpredictable changes, caused by several factors. The authors state that these transformations have accelerated in recent years in a new and complex social, political and economic environment that tends to absorb new ideas. In Brazil, there is no research on management analysis of market risk factors in construction sector.

This paper fills this important gap by presenting the main market risk factors in construction projects in Brazil, considering an economic crisis (in which competition increases and investments in technological innovation decrease), through a data analysis of the survey carried out with field professionals, done in a survey, verifying how they perceive market risk factors. In turn, the specific objective is the structuring of indexes for prioritization of risk factors, based on the application of the factor analysis in the risk events contained in each market risk factor.

The results of this research can be used as parameters for entrepreneurs, designers and projects' manager in civil construction that, based on the results, promote similar procedure in order to achieve effiency and assertiveness.

About the limitations of this research can be pointed the fact that as an investigative work in which criteria are established for the determination of the information, qualification of the results collected, interpretative analyzes, and then to promote the diagnosis, there are implicit risks of distortions and errors.

The activity of data collection requires a thorough knowledge of the topic, and this aspect may link the risk of assertiveness in the questionnaires. The misinterpretation of the questionnaire and the lack of attention on the part of the respondents are also a risk factor. Other factors may be cited as a risk to the development of the survey by the interviewees, especially not to expose company data, which they consider strategic and confidential, which may lead to difficulties in the elaboration of the diagnosis and to cause distortions to the conclusions, besides the difficulties of surveying of data. They may also simply make it difficult to return the questionnaires answered because of the limited availability of time for such occupation.

2. Literature Review

Mutti (2004) identified factors of influence in competitiveness as being: productivity (labor), product costs, quality standards, human resources performance, technology and innovation, company culture, information technology applied in the company , strategic planning, enterprise performance, customer requirements, management, the company's financial base, and market information and knowledge.

In agreement with Neto (1997), in the construction industry, rivalry increases due to scarcity of resources, almost no change costs and little product differentiation, and there is sometimes a certain brand fixation. The author argued that the profitability of the sector is not only badly affected because the exit barriers are low and the majority of companies are small and family run, which generates similar strategic interests among the companies, thus forming a good competition.

In the construction sector, small and medium-sized enterprises are compressed between the large companies that dominate the high-income market and the informal sector that robs them of middle- and low-income consumers (Rodrigues et al., 2013).

It can be said, in general terms, that the civil construction sector, mainly of buildings, is formed by a very large number of competitors with moderate rivalry, where the bargaining power of suppliers is relative due to the representativeness of the inputs and of the construction company; the threat of new entrants is high; the threat of substitute products is non-existent and consumers' bargaining power is small but increasing (Neto, 1997).

As stated by Kim et al. (2011) there are important points that significantly affect competition among construction companies: risk-taking under competition is an essential element in the construction business; builders may have their own individual attitudes of risk as part of their organizational culture that affect organizational behavior; competition is developed through the interaction of several competitors. Ultimately, different attitudes of risk between contractors can affect competition between them; the financial performance of a contractor may be affected by competition; and the goal of the builders is not to maximize short-term profit on specific projects, but to survive and grow in the long run.

Conforming to Araújo and Mutti (2005), the construction industry, even in European countries, has suffered a strong market constraint, which has forced the development of new forms of rationalization of the productive organization, aiming at performance. The authors state that in the face of this changing market, companies have generally realized that it is dangerous to act reactively at events and look for ways to influence their future.

Bougrain (2010) argues that the construction industry is often criticized for its inability to innovate, improve its practices and deliver value to its customers. The low level of research and development, the fragmentation of industry, the inability to learn from one project to another, the acquisition process mainly based on the price offered and the conservatism of construction site employees are often presented to explain this situation . According to Schwark (2006), there are several causes for the low adherence of construction companies to initiatives aimed at innovation. The first one is that the industry is very sprayed, that is, there are a large number of small companies operating in the market. As a consequence, they have less possibility and the structure necessary to dedicate efforts to innovation.

There are also some causes related to the current situation of the country. In this scenario, innovation is mistakenly seen as reducing the number of jobs, especially unskilled labor, due to the fact that its adoption presents an increase in productivity, which leads one to think of the need for less labor engagement. From this angle, factors such as the greater social return on the financial resources invested, the quality of the jobs involved and the quality of the construction product itself are ignored. Also, factors such as better qualification of the employed labor force and higher remuneration received by them due to this qualification are not considered. In a way, this situation limits the search for innovation by construction companies, which depends on greater discernment, qualification, motivation, participation and training of the team (Schwark, 2006).

As stated by Câmara and Bergamasco (2005), the industry receives influences from official regulatory interventions that impose constraints and uncertainties and may hinder innovations, since they usually require procedures rather than performance.

According to Lungisansilu (2015), studies have been carried out by professionals in the civil construction sector which point out that the quality of construction materials has been one of the main causes of structural collapse and important pathologies of buildings in Brazil and worldwide. investigations and construction accident analysis led by competent institutions, revealed that the numbers of problems in the buldings construction due to the lack of quality of the materials have been increasing exponentially, and this tends to grow more and more over time. The author states that these events lead to the weakening and loss of credibility of the sector.

This aspect of quality was also pointed out by Fang et al. (2004), highlighting that the loss due to the poor quality of the products delivered by the suppliers is quite high. Not only poor quality can lead to wasted time, but more seriously, it can result in local accidents. The authors state that an abundant supply of building materials can generally guarantee the supply of materials in a short period of time, thus, the loss due to delay of goods at the site of the work has low importance of risk. Despite this, the authors conclude that problems with material quality are likely to arise. To control the market, many suppliers have to reduce the price and agree with the delinquent contractors on loans. As a result, it is difficult to guarantee the quality of many materials.

Silva (2015) also points out that good management of the supply sector is fundamental to control the quality of materials and avoid delays in procurement and delivery. The author states that a material purchase planning, availability studies, pre-order strategy, requisition processing / control, relationship between various sectors and functions, receipt control, deadline compliance for all management activities of supplies, are essential.

Besides that, the workforce is the main asset in the construction project, even the construction companies are currently concerned about the use of technology to reduce costs, labor is still necessary to drive this technology (Salleh et al., 2016).

Also, as reported by Silva (2015), the Brazilian construction sector was handcrafted by the hands of mostly illiterate and technically unskilled workers, now the industry pays the price for years without investment in personnel training. The author also points out that the construction not only failed to invest in the improvement of its employees but also attracted a less qualified workforce, losing its professionals to the more attractive metallurgical, textile and automotive industries.

From the social point of view, the construction sector plays an important role in presenting a high labor absorption capacity (Moraes, 2009). Thus, according to Nascimento (2015), sectors such as construction that experience strong growth in a short period of time often face problems in hiring qualified personnel.

The heated market without a skilled workforce is considered a threat to the construction companies in general, since, with the increase in demand for real estate, more employees are needed to meet this contingent, and every customer seeks the quality of his work, precisely (Rodrigues et al., 2013). In order to avoid possible future reforms, the service provided must be executed with quality for customer satisfaction, and for this, qualification is needed.

Conforming to Jarkas and Bittar (2012), also corroborates this aspect, poiting out that the lack of skill and work experience undermines the productivity of the construction process. Poorly trained and unskilled operators are often responsible for poor quality and defective end products, as well as high material waste. In addition, their end products are almost always rejected, in whole or in part, by the inspection engineer, resulting in extensive and expensive rework, rectification or repairs. However, experienced workers possess solid intellectual skills, practical solutions to overcome obstacles and technical and motor skills, which lead to higher productivity, lower labor costs and better quality of final results. (Jarkas and Bittar, 2012).

It is possible to mention as the main cause of the delay of the tasks and rework in the construction sites the lack of communication between the manager and the contractor, that causes disagreements between the project that is in the paper and the execution, as well as the lack of capacitation of the contractors , both regarding the quality of execution of the work and the ability to analyze projects. With the delay in the tasks and the rework, the initial schedule tends to extend and with that the losses are aggravated (Mobuss Construction, 2014). The perception that companies do not honor their commitments puts at risk the future sales of the construction company and consumer confidence in the real estate market (Reis, 2010).

Samee and Pongpeng (2016) argue that in today's competitive construction industry, construction companies must constantly improve their design and corporate performance by continuously modifying their management strategies to increase the chance of winning construction contracts. The authors conclude that equipment management is a strategy that can support such improvement. The management of construction equipment aims to maximize the return on investment in fixed assets and to meet the needs of the project (Fan et al., 2007), which increases the performance of the construction company and improves its competitiveness (Prasertrungruang and Hadikusumo, 2009). Tatari and Skibniewski (2006) observed that effective equipment management plays an important role in building corporate success, suggesting that equipment management correlates positively with corporate performance.

Failures in the operation of machines and equipment at construction sites generate delays in the transportation of materials and in the execution of the services, which may impact the quality of the work (Slack et al., 2009).

One of the five most important causes of construction delays perceived by contractors is the failure and unavailability of equipment, according to a study by Sambasivan and Soon (2007). According to the authors, many of the contractors do not have the necessary equipment for the construction work, so they rent the equipment when necessary. During the time when there are many construction projects, the equipment is scarce and poorly maintained, leading to equipment failure and making progress difficult.

On the other hand, for the construction, the advantages of leased equipment, also called leasing, are related to the competitiveness of the companies. Leasing companies are usually able to use the best available technologies at each stage of the project without having to bear the costs of equipment acquisition, maintenance and depreciation (Yeh et al., 2011).

Hajej et al. (2015) state that technological obsolescence is a reality in the industry due to technological developments and the introduction of new equipment. In addition, the cost of acquiring new equipment has become very high. Based on these reasons, the authors conclude that more and more industries choose to rent equipment instead of buying it.

3. Methodology

This research is based on an exploratory research carried out between December 2016 and March 2017. In the firstphase, a bibliographic investigation was undertaken on Corporate Risk Management. In the second phase, the process of market risk management, the main market risk factors observed in the research, the relevance and the applicability of a market risk management model in Brazil were mapped.

In the third phase, the questionnaire was analyzed and the validation of content and construct of the results of the application of the questionnaire on market risk was performed to engineers and professionals working in the insurance and civil construction sector. In this Phase, data from a doctoral research were used and data were obtained with the objective of establishing a risk management model for the calculation of insurance of civil construction projects, based on the material collected. This article, however, uses part of the data collected with the application of the questionnaire, which are directed to define the main market risk factors in construction projects. The factors are identified based on the theory and the model is tested to obtain the consistency of the observed data, using the confirmatory factorial analysis.

In the fourth phase, a ranking of the market risk factors was made, seeking to establish a hierarchy, by degree of relevance for the professionals of the area, based on statistical tools.

Finally, in the fifth phase, an analysis and discussion of the results was carried out, comparing the results found in the survey research with the research of the bibliography on market risk.

4. Results and Discussion

4.1. Sample Size and Respondents Profile

As the number of variables increases, the acceptable level to consider a significant factor load decreases. The adjustment for the number of variables is increasingly important when moving from the first factor extracted to later factors (Cruz and Topa, 2009).

With the established objective of achieving a power level of 80%, the use of a significance level of 0.05 and the proposed inflation of standard errors of factor loads, Table 1 contains the sample sizes required for each load value factorial considered significant.

The preparation of the questionnaire was done through Google Docs and sent by email to professionals from various sectors of the construction industry. Considering that the sample was chosen to represent the population to which it belongs, and that due to the lack of knowledge of its size, it would be costly, time consuming or even impracticable to study its totality, a non-probabilistic sampling was used for this purpose.

The survey was answered by 105 professionals, 36% civil engineers and 11% architects. Therefore, for a sample of 100 responses, a minimum loading factor of 0.55 is required.

Table 1. Loading factor size significance

Loading Factor	Sample size required for significance
0.30	350
0.35	250
0.40	200
0.45	150
0.50	120
0.55	**100**
0.60	85
0.65	70
0.70	60
0.75	50

According to the results of the analyzes, the majority of the respondents, 73%, have a knowledge of regulating the very good in relation to risk, while 4% of the sample has no knowledge on the subject. Regarding the time of professional performance, 44% have more than 21 years of experience and 20% between 11 and 20 years.

The degree of education is predominantly masters with 44%, followed by graduate studies with 26%. Regarding the conduction or participation in works, 25% of respondents have 41 or more works conducted and 27% up to 10 works, meaning a high portion of the sample that works in complex projects. However, the same can not be said with regard to the risk analysis of these same projects, since 39% of the respondents never acted on this subject, reinforcing the low maturity in risk management in organizations, even if in civil works a thorough analysis is required of the risks, since they have many variables that can impact their progress.

4.2. Instrument Reliability and Content Validation

The reliability of the questionnaire was obtained through the internal consistency of the constructs, based on Cronbach's alpha coefficient, through SPSS software. The lower limit for Cronbach's alpha to be accepted was 0.7 (Hair et al., 2011). If any construct does not reach this value, it will be reevaluated and can be eliminated from the group. After this, this construct will have its consistency verified again by the new Cronbach’s alpha without this element. The results are shown in Table 2.

All the constructs presented adequate results in relation to the reference Cronbach's alpha value, so there are guarantees that the questionnaire is in agreement with its conceptual definition, it is one-dimensional and meets the necessary levels of reliability. In addition, it was possible to conclude that there is no need to exclude or re-evaluate any variable from the analysis. The result of the analysis was evaluated as very good, mainly because it is a new instrument.

After the reliability analysis, the validity of the content was performed by checking the data loss rate, i.e., unanswered questions or those marked on the NE scale (“I did not understand the statement”). And it was verified that there was a loss of only 1.9% for the first construct "High Competition."

Therefore, none of the constructs presented more than 10% of unanswered questions, so it can be affirmed that the final structure of the questionnaire is evaluated as well structured.

Table 2. Cronbach’s alpha

Construct	**Description**	**Cronbach’s alpha**	**Reference value**
6.1	High competition reduced	0.755	> 0.7
6.2	Capacity for technologica l nnnovation	0.870	> 0.7
6.3	Reduced quality of construction materials	0.790	> 0.7
6.4	Reduced quality of labor	0.921	> 0.7
6.5	Reduced quality of construction equipment	0.854	> 0.7

4.3. KMO and the Bartlet’s Test

The validation of the construct was performed by the factorial analysis confirmed by the SPSS program, in this way the extraction of the factors has already been pre-defined. From these factors it was possible to confirm if they form a correlated structure. The Kaiser-Meyer-Olkin (KMO) and Bartlett's Sphericity tests aim to verify if the application of the factorial analysis has validity for the chosen variables.

First, the Kaiser-Meyer-Olkin (KMO) test was performed, which indicates if the correlation patterns are relatively compact and with this factorial analysis can generate distinct and reliable factors, adopting the minimum reference value of 0.60 for a reasonable degree of adequacy of the sample (this value varies from author to author).

For the interpretation of the loads found, the first suggestion of Hair et al. (2011), which considers significant loads greater than 0.50, being higher than 0.30, which can be used after careful analysis by the researcher. Therefore, results that are less than 0.50, but greater than 0.30, will be studied in more depth. The assertions that have values less than 0.30, will be directly disregarded for the next analyzes, in order to guarantee their reliability.

The Bartlett’s sphericity test tests the hypothesis that the variables are not correlated in the population, if P-value is less than 0.05, we reject this hypothesis. For this, a maximum limit of 0.05 was adopted. Table 3 presents the results of each factor.

Table 3. KMO and the Bartlet’s test

Construct	**KMO**	**Bartlett's sphericity**
6.1	0.667	0.000
6.2	0.708	0.000
6.3	0.684	0.000
6.4	0.829	0.000
6.5	0.820	0.000

All the constructs had satisfactory KMO values, with emphasis on 6.4 and 6.5, which presented a high data explanation value (0.829 and 0.820 respectively). The

Bartlett's test was considered highly significant, with p-values lower than 0.001, confirming the adequacy of the factorial analysis.

4.4. Factor Analysis

After performing the validations of the content and constructs, we sought to identify whether the affirmations are effectively part of the same grouping factor, also called confirmatory factorial analysis. The latent root criterion will be used to extract the factor, so the number of components will be extracted by values of variance greater than 1.00. Table 4 represents the values obtained and their respective grouping factors, through the analysis of the main component of each construct.

Table 4. Latent root criteria analysis

Total variance explained - Construct 6.1		
Component	Total	% of variance
1	**2.317**	**57.915**
2	0.874	21.851
3	0.504	12.606
4	0.305	7.628
Total variance explained - Construct 6.2		
Component	Total	% of variance
1	**2.881**	72.033
2	0.667	16.686
3	0.317	7.926
4	0.134	73.355
Total variance explained - Construct 6.3		
Component	Total	% of variance
1	**2.479**	61.975
2	0.707	17.664
3	0.580	14.490
4	0.235	5.871
Total variance explained - Construct 6.4		
Component	Total	% of variance
1	**3.238**	80.941
2	0.362	9.043
3	0.216	5.388
4	0.185	4.629
Total variance explained - Construct 6.5		
Component	Total	% of variance
1	**2.478**	69.524
2	0.484	12.088
3	0.397	9.919
4	0.339	8.469

Each construct presented only 1 component, confirming that each one actually forms a group. Therefore, five risk factors were identified based on the statements made.

Combining this criterion with the criterion of the total variance explained, it was observed that the construct 6.1 presented a solution that explains 57.915% of the total variance, being below the reference pointed by Hair et al. (2011), which is 60%. For this, the commonalities of each variable of this same construct, presented in Table 5, were verified.

Note that the extraction of variable 6.1.2 is below 0.5, thus presenting a low power of explanation of this variable by the factor. In this case, by removing this variable from factor 6.1 and applying the factorial analysis again, the Kaiser-Meyer-Olkin (KMO) and Bartlett's Sphericity tests are checked again and the total variance criterion explained (see Tabled 6 and 7).

Table 5. Construct 6.1's commonalities

Variable	**Inicial**	**Extraction**
6.1.1	1	0.560
6.1.2	1	**0.452**
6.1.3	1	0.713
6.1.4	1	0.591

Table 6. New KMO and the Bartlett's test – 6.1

Construct	**KMO with item 6.1.2**	**KMO without item 6.1.2**
6.1	0.667	0.610

Table 7. Total variance explained in construct 6.1 excluding item 6.1.2

Total variance explained - Construct 6.1		
Component	Total	% of variance
1	2.003	66.780
2	0.691	23.036
3	0.306	10.184

The construct presented a lower KMO value than the previous analysis including item 6.1.2, but it remains satisfactory for the research. The Bartlett's test is still considered highly significant, with p-value less than 0.001 and with a solution explaining 66.780% of the total variance explained, greater than the 60% criterion.

Nevertheless, item 6.1.2 will be considered for this research, since 57.915% is a value very close to the reference value, mainly for a first version of the questionnaire, besides not losing the data of this variable.

After confirming the grouping, we sought to identify the loading factors of each variable, through the component matrix, as shown in Table 8.

Table 8. Loading factor

Assertive	**Loading Factor**
6.1.1	0.749
6.1.2	0.673
6.1.3	0.844
6.1.4	0.769
6.2.1	0.850
6.2.2	0.878
6.2.3	0.890
6.2.4	0.772
6.3.1	0.643
6.3.2	0.791
6.3.3	0.893
6.3.4	0.802
6.4.1	0.876
6.4.2	0.914
6.4.3	0.899
6.4.4	0.910
6.5.1	0.838
6.5.2	0.824
6.5.3	0.868
6.5.4	0.804

By guaranteeing statistical significance based on sample size, Hair et al. (2011) suggests that for a sample of 100 respondents, factorial loads above 0.55 or greater are significant for factorial analysis. Analyzing table 8 above, it can be identified that all assertions have a loading factor above 0.60, so all factor loads are considered significant for the research.

4.5. Index Construction

Hair et al. (2011) states that the factorial analysis, which extracts factors from the sets of variables, creates an ordering of the importance of the constructs, indicating that the first factor would be more important than the second in explaining the observed variability.

Furthermore, Carlos (2013) suggests that the index be calculated through the weighted average between the responses of the Likert scale values and the loading factor obtained in the factorial analysis. In this way, the variable more related to the construct will have a greater weight in the determination of its index. The following tables 9 and 10 present the result of using this method.

Table 9. Loading factor x mean of responses

Assertive	Mean of responses	Loading factor x Mean of responses
6.1.1	3.87	2.90
6.1.2	4.04	2.72
6.1.3	3.71	3.13
6.1.4	3.57	2.75
6.2.1	3.61	3.07
6.2.2	3.47	3.04
6.2.3	3.39	3.02
6.2.4	3.67	2.83
6.3.1	3.98	2.56
6.3.2	3.85	3.05
6.3.3	3.97	3.55
6.3.4	3.75	3.01
6.4.1	3.85	3.37
6.4.2	4.10	3.74
6.4.3	4.11	3.69
6.4.4	4.17	3.80
6.5.1	3.98	3.34
6.5.2	3.93	3.24
6.5.3	4.04	3.51
6.5.4	4.04	3.25

Table 10. Index and order of relevance

Assertive	Description	Index
6.4	Reduced Quality of Labor	4.06
6.5	Reduced Quality of Construction Equipment	4.00
6.3	Reduced Quality of Construction Materials	3.89
6.1	High Competition	3.79
6.2	Reduced Capacity for Technological Innovation	3.53

The highest indices represent the risk groups that participants consider most important in relation to the occurrence. Therefore, the reduced quality of labor is considered as the most important subgroup to be considered in market risk, followed by the poor quality of construction equipment. It can be concluded that, in general, the reduction of the quality as a whole was considered the most relevant of the possibilities of market risk.

5. Conclusion

The initial objective of this article is to rank market risks in construction projects by analyzing how the professionals of the area perceive and consider important the risk factors related to the category.

After the questionnaire was applied, it was found, from the participants' answers, that none of the listed risk factors presented an average of less than 3 on the Likert scale. That is, in general professionals who are in some way related to the construction industry considered that all market risk factors are at least relevant and relevant to the venture's risk analysis.

In addition, for a first version of the questionnaire sent to the participants, very high reliability results and a small percentage of data loss were obtained with participants who did not answer some affirmations. This confirms a validation of the research where the content was presented clearly and effectively measures what was proposed, not having to eliminate or rewrite any affirmative of the questionnaire.

It is also possible to identify, from the profile of the participants, that there is a low maturity in risk management in organizations, even if in civil works, a thorough risk analysis is required, since they have many variables that can impact their progress. About 39% of the respondents never acted with risk analysis, with more than 50% of the sample already working in more than 10 construction sites.

Finally, after applying the factorial analysis from the answers obtained, the degree of correlation between the subgroups of the risk factors was confirmed first, since the groups were previously defined. It was also possible to establish a ranking of the degree of importance in relation to the market risk, and the first one considered more relevant was the risk of reducing the quality of the workforce. The second in the order of degree of importance was also associated with quality being the reduction of the quality of the construction equipment and thirdly the reduced quality of the materials.

With regard to the first three factors considered most relevant, the low quality of the workforce for the civil construction sector directly impacts the costs, the term and mainly the quality of the work, since the reworking is constant during as well as post work, generating waste of resources, be they material, personnel and time. In addition, the customer's perception about the final product is compromised, as the quality does not meet their expectations. Even the builder redoing a service that was out of quality or different from scope, the client's view of the company is tied to that negative experience.

The reduced quality of the materials, in turn, also impacts the cost and the final quality of the project, since the material of poor quality over time causes pathologies in the building such as infiltration, detachment of floors and even collapse of the structure. On the other hand, the quality of the equipment implies directly in the deadlines of the work, that is, the failure or the breakdown of the equipment generate delays of difficult recovery, but also impacts the costs of losses of materials due to misuse of the equipment or even accidents.

Contrary, the reduced technological capacity has been considered less relevant as a market risk factor can be explained by the lack of incentive in the construction sector as a whole, since this industry has several small companies with low research development and heavy reliance on suppliers. In addition, this sector is very conservative and, therefore, there is a preference for constructive methods and materials already used in previous works and that have already worked.

Future research based on this paper can conduct several case studies in order to examine the sensitivity of the perception of risk. In addition, it allows to evaluate the maturity of companies in relation to risk management through the years. It is recommended a deepening of the elements of risk that involve this model, that can be influenced to a greater or smaller scale, according to other factors.

These research has provided a first step in the direction of analyzing market risk factors that is critical on a construction environment, contributing to elucidate various aspects of good practice in risk management.

This research can be expanded to other countries, applying the same methodology used. Each country has its own characteristics that can be evaluated through the application of the same questionnaire, analyzing the perception of the market risk of its professionals and the degree of maturity in risk management of its companies. This allows a comparison of data between countries, leading to a more in-depth assessment of the degree of importance of each risk factor.

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Appendix A. Questionnaire

Federal Fluminense University

School of Engineering

Questionnaire

Respondents Profile

1. **Name:**
2. **E-mail:**
3. Profession: ( ) Civil Eng. ( ) Electrical Eng. ( ) Other
4. **Academic degree**: ( ) Graduated ( ) Specialization ( ) Master ( ) PhD
5. **Time in which you work professionally in engineering:** ( ) up to 2 years ( ) 3 to 5 years ( ) 6 to 10 years ( ) 11 to 15 years ( ) 16 to 20 years ( ) + 21 years
6. **Level of knowledge on the subject 'Risk Analysis'**: ( ) Excelent ( ) Very good ( ) Good ( ) Regular ( ) Little ( ) Very little ( ) None
7. **How many civil works and projects have you conducted or participated in?** ( ) up to 5 ( ) 6 to 10 ( ) 11 to 15 ( ) 16 to 20 ( ) + 21

Affirmations are grouped by affinity and should be marked according to the personal perception about their agreement with the type of risk being described and if it should be really considered in the overall risk analysis in Construction projects, being classified as

• SD - Strongly Disagree;

• D - Disagree;

• NA-Do not Agree, or Disagree (Neutral Position);

• A - Agree;

• AC - I agree completely;

• NA - Does not apply to risk analysis in construction projects.

AFIRMATIVES	SD	D	NA	A	AC	NA
6 – MARKET RISKS						
6.1 – HIGH COMPETITION - As a result of the high competition, the company considers the risk of occurring:						
6.1.1 Jobs' loss.	☐	☐	☐	☐	☐	☐
6.1.2 The reduction of the amounts charged resulting in a decrease in profits.	☐	☐	☐	☐	☐	☐
6.1.3 Costs' increase of hiring labor.	☐	☐	☐	☐	☐	☐
6.1.4 Material costs' increase.	☐	☐	☐	☐	☐	☐
6.2 – REDUCED CAPACITY OF TECHNOLOGICAL INNOVATION - Due to the reduced capacity of technological innovation, the company considers the possibility of occurring:						
6.2.1 The reduction of the amounts charged resulting in a decrease in profits.	☐	☐	☐	☐	☐	☐
6.2.2 Project's delays.	☐	☐	☐	☐	☐	☐
6.2.3 Project's damage.	☐	☐	☐	☐	☐	☐
6.2.4 Difficulties in obtaining new services by compromising the company's image in relation to the competition.	☐	☐	☐	☐	☐	☐

6.3 – REDUCED QUALITY OF CONSTRUCTION MATERIALS - The company foresees the risk of:						
6.3.1 Pay more for higher quality materials in more distant places.	☐	☐	☐	☐	☐	☐
6.3.2 Commit the quality of construction by using low quality materials.	☐	☐	☐	☐	☐	☐
6.3.3 Delays in the works with the tasks of rework, by use of materials of low quality.	☐	☐	☐	☐	☐	☐
6.3.4 Accidents in the work, by use of materials of low quality.	☐	☐	☐	☐	☐	☐
6.4 – REDUCED QUALITY OF LABOR- Caused by poor quality workmanship, the company considers in its projects the risk of:						
6.4.1 Make losses.	☐	☐	☐	☐	☐	☐
6.4.2 Delays' risks.	☐	☐	☐	☐	☐	☐
6.4.3 Work's accidents.	☐	☐	☐	☐	☐	☐
6.4.4 Material losses.	☐	☐	☐	☐	☐	☐
6.5 – REDUCED QUALITY OF CONSTRUCTION EQUIPMENT - Due to the poor quality of construction equipment, the company considers the risk of:						
6.5.1 Material losses.	☐	☐	☐	☐	☐	☐
6.5.2 Costs' increase in the transportation of equipment to the site of the work.	☐	☐	☐	☐	☐	☐
6.5.3 Work's accidents	☐	☐	☐	☐	☐	☐
6.5.4 Delays' risks.	☐	☐	☐	☐	☐	☐