UFSM

REVISTA DE ADMINISTRAÇÃO DA UFSM
Brazilian Journal of Management
ReA UFSM

ISSN 1983-4659
OPEN ACCESS

Rev. Adm. UFSM, Santa Maria, v. 16, n. 3, e9, 2023 https://doi.org/10.5902/1983465969869
Submitted: 04/26/2022 • Approved: 06/272023 • Published: 11/09/2023

Original Article

Risk management in civil construction: the contractor's perceptions

Gestão de risco na construção civil: a percepção dos construtores

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ABSTRACT

Purpose: This study seeks to understand how the managers of the civil construction industry perceive risk management in their projects and businesses based on a case study in the region of Volta Redonda-RJ.
Design/methodology/approach: Primary data was collected through questionnaires and interviews. The primary quantitative data were analyzed using Paraconsistent Logic and presented with descriptive statistics.
Findings: It was found that 87% of the sample did not go through any steps of the risk management process. For those that did, the steps were essentially intuitive and informal. Further, a distortion was observed on behalf of the managers regarding the understanding of what risk management is, what it is helpful for, and the difference between their projects and the business itself.
Practical implications: Although not generalizable, the research results show a high appetite for risk on the part of contractors but a low willingness to absorb its effects.
Originality/value: Studies that apply paraconsistent logic to understand builders' perceptions of the importance of risk management are scarce in the literature. Also, there is little literature about the management aspects of this industry.

Keywords: Risk management; Business management; Risk in construction projects

RESUMO

Objetivo – Este estudo busca compreender como os gestores da construção civil percebem a gestão de riscos em seus projetos e negócios a partir de um estudo de caso na cidade de Volta Redonda-RJ.
Método – Os dados foram coletados por meio de questionários e entrevistas. Os dados quantitativos primários foram analisados pela Lógica Paraconsistente e apresentados por meio de estatística descritiva.

Resultados – Constatou-se que 87% da amostra não passou por nenhuma etapa do processo de gestão de riscos. Para aqueles que o fizeram, as etapas foram essencialmente intuitivas e informais. Além disso, observou-se uma distorção por parte dos gestores quanto ao entendimento do que é gestão de risco, para que serve e a diferença entre seus projetos e o próprio negócio.
Implicações práticas – Apesar de não generalizáveis, os resultados da pesquisa mostram um alto apetite ao risco por parte dos construtores, mas baixa disponibilidade de absorção de seus efeitos.
Originalidade – Estudos que aplicam Lógica Paraconsistente para entender a percepção dos construtores a respeito da importância da gestão de risco são escassos na literatura. Além disso, há pouca literatura sobre os aspectos de gestão desta indústria.

Palavras-chave: Gerenciamento de risco; Gestão de negócios; Risco em projetos de construção

1 INTRODUCTION

All civil construction projects present risks (Rehman, Thaheem, Nasir, & Khan, 2020; Regis, 2023). Their projects are unique and complex, with numerous actors involved in the planning and execution stages, and require significant investments. The contractor, understood as the manager of the construction company, assumes an exceptionally high risk, especially when contracting, given that, as experienced as they may be, they are not able to fully predict all potential contingencies in their action plans (Sivagami & Sarath, 2018; Siraj & Fayek, 2019).

In the civil construction industry (CCI), the risk is evident. It can be described as exposure to events that may culminate in economic losses, occurring through a convergence of vulnerabilities and threats, and being noticeable due to their impact on the time, cost, and quality of projects and final products (Ameyaw, Chan, Owusu-Manu, & Coleman, 2015; Dixit, Sharma, & Singh, 2020).

Seeking to assist managers from the CCI in risk management (RM), the use of management support techniques for the decision-making process is widely recommended in the literature, highlighting Fuzzy Logic Valuation and its association with Analytic Hierarchy Process (Tavakolan & Etemadinia, 2017; Cavalcante, 2019); as well as the chapter on RM in civil construction projects proposed by the Project Management Institute – PMI (PMI, 2016; Otero, 2018); and the Building Information Modelling Methodology or BIM

(Mota, 2017; Rehman et al., 2020). In practice, however, there is no universally recognized model for RM in projects in this industry that would include the full development of the project proactively (DeMarco & Thaheem, 2014; Krechowicz, 2020).

Along with the lack of a consensus regarding RM methodology in construction, in Brazil, construction companies operate within a highly volatile political and economic environment, commonly presenting weaknesses in the planning and controlling of their projects (Gonçalves, 2015; Beltrão & Carvalho, 2019). Contractors avoid management processes for fear of excess internal bureaucracy in their businesses and to reduce costs (Zhao, Hwang, & Phng, 2014; Vergara, Teixeira, & Yamanari, 2017). This aversion results in deficient RM, stemming from a habit of only considering issues such as deadlines and cost and based on a frequently out-of-date physical-financial schedule (Schocair, 2021).

Furthermore, the literature points out that RM in CCI is directly connected with intuition and common sense, as well as with the project manager's experience, leading to a plan that can adapt to the project manager's capabilities, directly influencing the project's performance and quality (Sá, 2016; Pawar & Pagey, 2017; Ekung, Adu, & Lashinde, 2020). Finally, taking management considerations and administration, small to medium-sized construction companies tend to be centralized in one person, leading to delays and incomplete administrative processing (Magalhães, Mello, & Bandeira, 2018; Behling & Lenzi, 2019).

The discussion about RM in CCI is not enough explored in the academic literature (in civil engineering or management areas) nor in the industry documents and studies led by industrial entities or associations, opening a research stream to be explored in this research.

Considering this industry's intrinsic risk element, its management profile in construction projects, and the lack of comprehensive methodologies for the CCI, the question is: How do the managers of the CCI in Volta Redonda-RJ perceive RM in their projects and businesses? This research aims to analyze the perception of builders from Volta Redonda-RJ about RM in construction and business ventures. For several reasons related to the convenience of primary data collection and access to companies in a

contingency period imposed by SARS-COVID-19, it was decided to restrict this study to Volta Redonda. The city is a regional capital in the south of the State of Rio de Janeiro, Brazil, and a relevant economic center for CCI.

A qualitative and exploratory methodology was outlined based on a case study with CCI in the city. Data were obtained by questionnaire and analyzed using Paraconsistent Logic and descriptive statistics. Additionally, to clarify some points, interviews were conducted with company managers.

The present work is relevant for several reasons. It is believed that the deepening of studies on how RM is perceived by members of CCI, highlighting nuances in the decision-making process, enriches academic debates on the subject. In short, the results of this research reinforced the arguments of Krechowicz (2020) by identifying that, in the analyzed sample, a global tool for RM in construction projects is not used or even known; our results are in line with the statements by Zhao et al. (2014) and Vergara et al. (2017) that builders fear an excess of bureaucratization in their daily tasks. However, this study extrapolates this statement. Our results indicate a distortion in understanding what internal bureaucratization is for builders, making them reject RM protocols and perceiving them as bureaucratic when meticulous and time-consuming. Finally, it was found that the perception of risk only happens after identifying financial losses, as the seminal author Gitman (1997) proposed, and more recently Hanioglu (2022), indicating an excessively superficial, linear, and limited perception of the builders about risk. Regarding the practical contributions of the research, it is understood to serve as an alert for the CCI and undergraduate courses in administration and civil engineering. By identifying that the managerial behavior of the builder has yet to specialize in the face of an issue as essential as risk, despite the ongoing debates, the theory is not reaching practice.

This article is organized as follows. First, it presents the theoretical foundation, followed by the methodological procedures. Subsequently, the results obtained are presented together with the discussion, ending with the conclusions.

2 RISK MANAGEMENT IN CCI

Due to the construction projects complexity and the large number of variables involved in the elaborating process and executing these ventures - such as environmental, material, logistical, labor, pricing, company and project cashflow, legal, marketing, and political matters, amongst others -, the level of risk inherent to the ventures can be extremely high (Dikmen, Birgonul, Anac, Tah, & Aouad, 2008;Kumar & Narayanan, 2020; Regis, 2023).

Although the concept of risk is widespread, there is no unanimous definition. There is consensus in the literature that the risk perspective should be understood as an exposure (of a project, company, person, or situation) to undesirable events whose impacts and probability of occurrence can be estimated, occurring where vulnerabilities and threats are found (Zhong, Xu, Chen, & Goh, 2020). Additionally, the risk is seen as an event with potential economic losses (Gitman, 1997; Shibani et al., 2022).

In CCI, the risk is generally perceived on the impact over time, cost, and quality of projects, products, services, or businesses (Heckmann, Comes, & Nickel, 2015; Ameyaw et al., 2015; Pawar & Pagey, 2017; Dixit et al., 2020).

Thus, risk can be understood as the probability of an event that could jeopardize the project's viability (Shibani et al., 2022). Another factor that drives risk in the CCI is the volume of workers that this industry absorbs. The issue of high staff turnover and the low level of education labor in this industry are obstacles to implementing training and specializations. This dynamic causes losses, delays, and rework (Catelan & Cunha, 2023).

The RM can be considered a culture that benefits the organization/project and enables the management of problems (Shibani et al., 2022). Usually, it involves detailed planning of the activities to be realized, using previously structured internal data from the organizations, thereby avoiding, reducing, minimizing, or absorbing undesirable events (Siraj & Fayek, 2019). Such planning requires critical analysis, and the stages of identification, evaluation, treatment, and control converge on the concepts of quality

management outlined in the PDCA cycle (Plan, Do, Check, and Act), following a trend of continuous evaluation and improvement (PMI, 2016; Calôba & Klaes, 2018). The most crucial aspect of RM is the identification of events. From this starting point, the event's impacts can be estimated, and reduction, absorption, or mitigation strategies can be outlined, in addition to allowing for the undertaking/venture's viability evaluation before starting (Siraj & Fayek, 2019; Lenderink, Halman, Boes, Voordijk & Dorée, 2022).

However, regardless of the organization of the company's information, the strategies for dealing with risk (elimination, reduction, acceptance, and transference) are theoretically the same and can be categorized according to two distinct approaches (Lenderink et al., 2022). The holistic approach proactively considers RM, while the fatalistic approach considers it inevitable. Independent of the category, risk acceptance should be elaborated, recognized during the planning stage, and carried out according to the financial and technical reach of the respective venture/business. Moreover, risk can be considered in this classification through an active (when there is a previously developed action plan) or passive response (Krechowicz, 2020).

According to this approach, risk reduction (or absorption) happens when managers do not recognize it (unintentionally or deliberately), compelling them to assume it as liabilities or losses. On the other hand, risk transference is the most used strategy in the CCI, usually occurring through contracting insurance, partnerships, and contracting outsourcing companies, amongst other possibilities (Krechowicz, 2020; Lenderink et al., 2022).

A manager, when implementing RM in the project portfolio, achieves more significant improvement in the execution of his work, which possibly results in greater profitability. It means that RM brings greater efficiency to the operation, reduces losses, and allows mistakes from previous projects to be avoided. Using historical data referring to the RM, builders leverage their capacity and attractiveness to customers, empowering their contracts (Shibani et al., 2022).

In contrast to the literature propositions, it is possible to see how common the lack of formal registration of risk events in the CCI is in practice (Qammaz & AlMaian, 2020).

There, the necessary data for identifying, analyzing, and making decisions related to risks are superficial, since contractors, in general, tend not only to neglect the importance of keeping information about the projects stored, but it is also evident that any information that may exist depends directly on the constant updating of construction workers, who are not necessarily qualified for such a task (Ekung et al., 2020).

At CCI, it is common for management deliberations and the administration of small and medium-sized companies to remain centralized in a single person, usually the contractor (also a company's owner or partner) (Magalhães et al., 2018), a habit that results in slowness and incompleteness of processes (Behling & Lenzi, 2019). This leadership profile outcome in general management, specifically for RM, is based on a vicious cycle of subjective analysis focused on an imprecise physical-financial project schedule (Conterato, 2018; Roghanian, Alipour, & Rezaei, 2018; Regis & Cardoso, 2021). When contractors seek to identify risk, the most utilized technique is brainstorming with realtors and other contractors without further formalization (Siraj & Fayek, 2019).

It occurs, essentially, due to the CCI manager's perception that the use of intuition and experience in decision-making is enough, reflecting a possible inability or disinterest on their part to transform theoretical administrative procedures into practice, which, when existent, are purely symbolic (Ekung et al., 2020; Kumar e Narayanan, 2020; Senthil & Muthukannan, 2021; Regis & Cardoso, 2021). Another critical point is that risk decisions are based on incomplete data, directly influencing the performance of the project and the company (Sá, 2016). Entrepreneurs fear an excess of internal bureaucratization, as they are unaware of simplified management tools and methods to help their businesses (Vergara et al., 2017). The aversion to more complex processes and procedures on the part of the manager causes gaps to occur in the study of risk in their projects, making it a habit to look only at issues such as deadlines and cost based on a physical-financial schedule that is often outdated (Hanioglu, 2022).

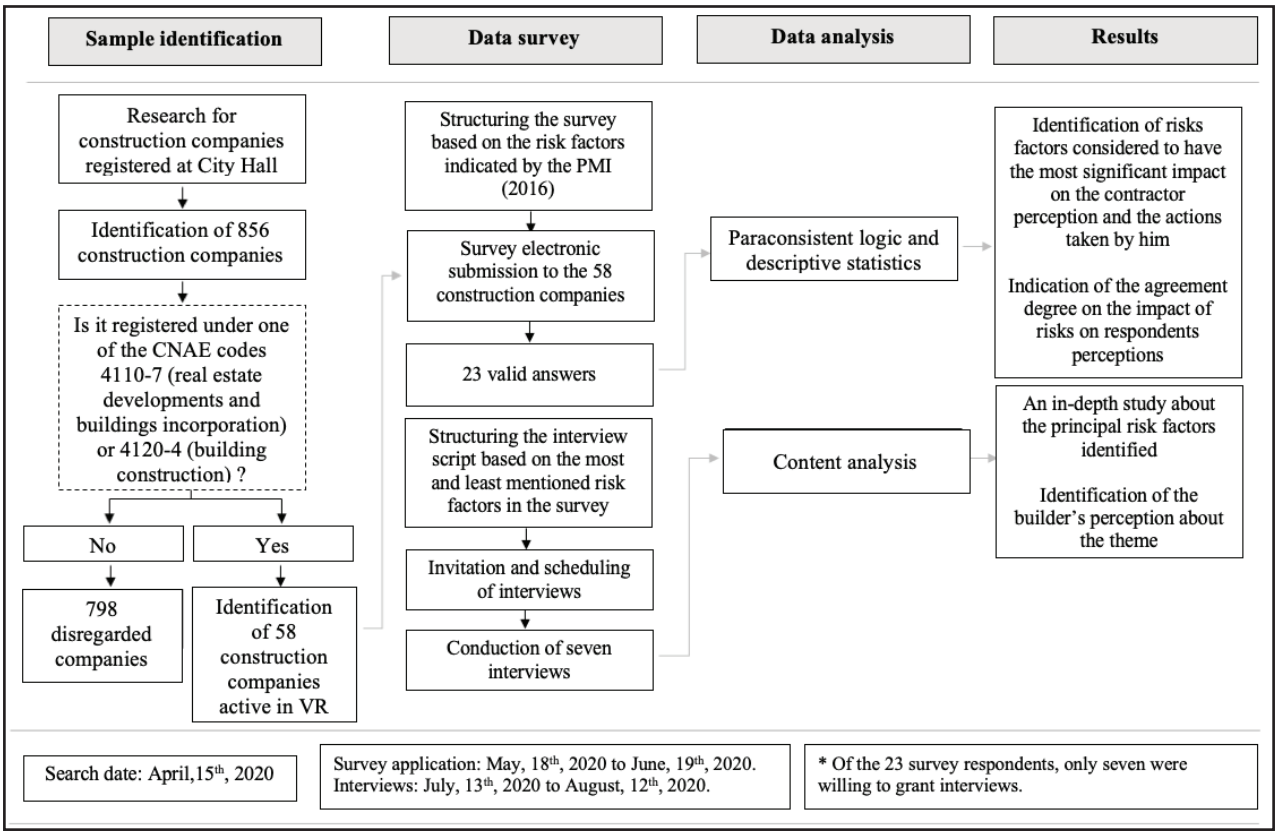
When such management options are combined with a neglect perception of the appropriate tools for RM, like a cause-and-effect diagram; SWOT matrix; decision

analysis tree; Delphi technique, amongst others, by the contractors, the projects of this sector tend to reach a critical risk level (Siraj & Fayek, 2019), which contractors perceive, interestingly, only when they lose money (Gitman, 1997; Shibani et al., 2022).

3 RESEARCH PROCEDURES

Seeking to identify how contractors carry out the RM in their projects in companies based on Volta Redonda (VR), indicating which events they consider critical and clarifying what measures were taken in the face of such risks, this research was methodologically structured according to Figure 1. The choice of CNAE codes 4110-7 and 4120-4 aligned with the research objective, as it included construction companies. Thus, we understood that excluding professionals registered as individual micro-entrepreneurs (bricklayers, painters, plumbers, interior designers, landscapers, etc.) was necessary.

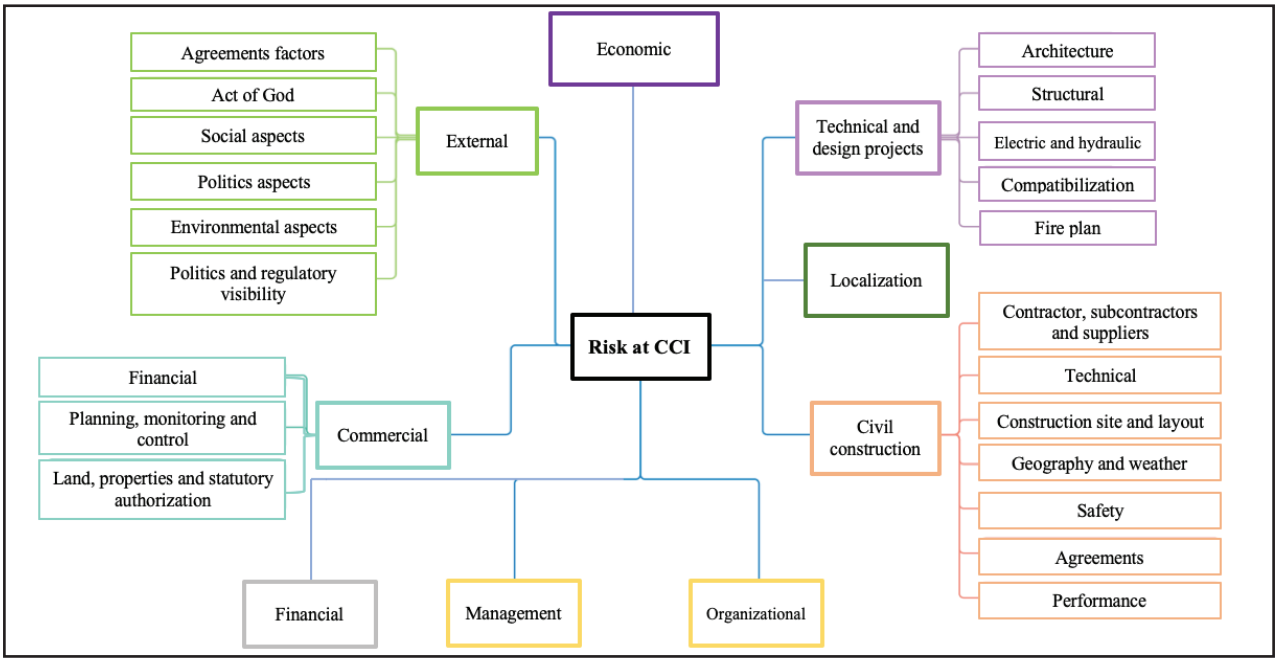
Figure 1 – Data Collection and Analysis Pathway



Source: The Authors

The primary data was collected based on a questionnaire organized according to the structure proposed in the 2016 Construction Extension to the PMBOK Guide Third Edition (PMI, 2016), where risk events are categorized into nine main categories, as illustrated in Figure 2. Also, specialists in the CCI tested and validated the questionnaire before the application. They were asked to evaluate the questions' content, clarity, and simplicity, as Gerhardt and Silveira (2009) suggested.

Figure 2 – CCI risk categories



Source: PMI (2016)

Risk events common to the CCI that can become threats to projects were listed for each group. Table 1 briefly presents the nine categories and their nature. For more details on the items noted in each category and subcategory, see Appendix 1.

For each event indicated in Table 1, a questionnaire with a five-point Likert Scale was proposed, in which 5 represents a very relevant risk factor while 1 is a reasonably irrelevant one. Subsequently, for each of the nine risk categories (Figure 2), the respondents were invited to indicate their perception of the actual impact according to the Likert scale in case one of the events occurred. Finally, the contractors were asked to indicate which RM tools or methodologies were used in their projects.

Table 1 – CCI risk categories description

Main Categories	Risk Nature (possible risk related to...)
External	...factors external to the construction company, which are often risks that need to be absorbed or transferred.
Commercial	...the commercialization of projects is observed.
Technical and design projects	...architecture and engineering projects are observed.
Civil Construction	...the execution of the work itself is observed.
Economic	...economic issues of the company, projects, and local and global economy.
Financial	...the financial capacity of the project.
Management	...the management of the construction company and construction projects. It is related to the capabilities of the leader.
Organizational	...institutional issues of construction companies.
Localization	...the construction site is observed.

Source: PMI (2016)

For each event indicated in Table 1, a questionnaire with a five-point Likert Scale was proposed, in which 5 represents a very relevant risk factor while 1 is a reasonably irrelevant one. Subsequently, for each of the nine risk categories (Figure 2), the respondents were invited to indicate their perception of the actual impact according to the Likert scale in case one of the events occurred. Finally, the contractors were asked to indicate which RM tools or methodologies were used in their projects.

After obtaining the responses (23 of 58)[1], the events identified were organized from the most to the least mentioned and classified arbitrarily into four groups by color, with red indicating 19 to 23 indications, orange 13 to 18 indications, yellow 7 to 12 indications, and grey 1 to 6 indications (Appendix 1).

The method proposed by Sanches, Marietto and Paixão (2011) was used to analyze the information collected. A qualitative approach to examine such data types, a model whose core represents opinions and feelings, is called Paraconsistent Logic. The objective is that knowledge is modeled by observing the evidence while applying logic, generating data close to human rationality, and proving appropriate for this research.

[1] Incomplete or duplicate responses obtained in the questionnaire were disregarded.

This analysis converts[2] the collected data into degrees of belief and disbelief (μ_1 and μ_2, respectively) and transforms them into degrees of certainty (G1) and contradiction (G2). Based on these data, it is possible to interpret the results presented in Table 2. Numerical data that did not use the Likert Scale were analyzed according to the descriptive statistics protocols.

The interviews (7 of 23) are owners or partners of construction companies, with five participating actively in the sector employers' union, some in leadership roles in the city and throughout Rio de Janeiro state. The interviews followed a semi-structured script based on the literature and the questionnaire results. The content was analyzed according to the protocols proposed by Bardin (2011)[3].

During the research, some limitations and challenges were identified, such as the possible personal involvement of the researchers in the subject matter, which was dealt with via minimization through strict methodological techniques. Additionally, the difficulty in accessing the companies' information, the social distancing due to the SARS-Cov-19 pandemic, and the low number of responses obtained for the questionnaire, 23 out of 58, as well as the number of interviews, 7 of 23 possible interviews. Such circumstances made it not possible to draw generalizations regarding the phenomenon analysis.

4 RESULTS PRESENTATION AND DISCUSSION

Regarding gender, a male predominance was identified in the respondent profile (73.9% in total), with an average age of forty years old. Around 82.6% reported having completed a college degree or higher. And it was verified that 95.7% considered themselves professionals in an exclusive decision-making position concerning their projects' risk. Such numbers indicate that the analyzed sample fits with the objectives

[2] For more details, see Schocair (2021), which contains the parameters used to classify the degrees of belief and disbelief and degrees of certainty and contradiction.

[3] Due to its objectivity, systematization, and inference as methodological characteristics. This method consists of three stages: pre-analysis; exploration of the material; and the treatment of results, inference, and interpretation. The pre-analysis consists of systematizing the initial ideas and establishing indicators for interpreting the information (Bardin, 2011).

outlined in the research, resulting in the global perception of leadership, providing the collected data with greater importance. The data from the surveyed sample, especially on risk decision-making, corroborate the literature by Magalhães et al. (2018), who claim that in the CCI, the tendency to centralize decisions in the contractor is still present in business management processes, reality identified in Volta Redonda.

The respondents listed 151 risk factors, with 64 classified as low incidence and low impact (grey group); 60 as median frequency and low impact (yellow group); 25 as median incidence and high impact (orange group); and two as high incidence and high impact (red group), as presented in Appendix 1. Table 2 shows the degree of perception of risk impact indicated in questionnaires from the participants' perspective.

Gitman (1997) and Shibani et al. (2022) state that risk is often understood when perceived as economic and/or financial losses. Factors that, according to the data obtained, are the most significant concern to the builders of Volta Redonda, validating the arguments in the literature. Based on the indication of the proposition agreement degree, both the economic factors (μ_1=0.9139) and the financial factors (μ_1=0.8696) are considered by contractors as a very strong agreement and substantial agreement about the relevance of this kind of risk impact to their projects, respectively. The interviewers considered these categories as the most significant tension points in their business, given that clients with funding limitations frequently finance the ventures, and the impacts that economic instability generates are widely perceived in CCI.

As Ameyaw et al. (2015) and Dixit et al. (2020) state, the contractor assumes a high level of risk, and, according to Gitman (1997) and Shibani et al. (2022), it is natural that its focus is to reduce to the maximum the possibilities of financial losses for itself and for the client. Moreover, as the research data indicate, our participants corroborate this conception. They understand that the risk is not entirely their responsibility in the event of economic and financial losses. About 56.5% of the sample analyzed transferred their risk effects (financially speaking) to the client. In the literature, the transfer is present as a risk mitigation strategy (PMI, 2016). The most common in the

CCI is insurance (property and in case of accidents) (Merlo et al., 2022), allowing us to indicate the identification, in this surveyed sample, of behaviors that overflow in the literature.

The respondents considered the localization category relevant with tangible action plans and manageable impacts (μ_1=0.7826). It was possible to infer that the contractors agree with the possibility of liabilities from risks stemming from this category. However, they do not recognize them as having a significant impact. Such perception was confirmed in the interviews. According to the contractors, when these kinds of risk events occur (such as logistical problems), there is rarely prior planning for damage control or productivity maintenance, indicating a particular predisposition towards risk absorption.

Siraj and Fayek (2019), Sivagami and Sarath (2018), and Manenti (2017) states that even if risk planning is carried out for construction projects, the same happens in the work planning stage from the anticipation of events, simulating them and their effects for the project. In the meantime, Ekung et al. (2020) complement this by arguing that during the execution of such procedures, intuition is used more than data, reflecting a high appetite for risk from contractors. Thus, this type of protocol, although commonly practiced, does not guarantee an adequate risk plan; the most common attitude of managers is to react to events.

The analysis of risk perception related to the technical aspects of projects demonstrated substantial and relevant agreement among the contractors (μ_1=0.8696). They consider the risk events in this category to have a considerable capacity for affecting their projects. Yet, according to Appendix 1, the items most acknowledged by the participants about this category are correlated with planning. However, according to the interviewees, besides these tasks being entirely under the control and responsibility of the contractor, events such as these have a common occurrence. This behavior highlights a context of task centralization that can result in an organization with incomplete management processes, in line with the literature (Magalhães et al., 2018;

Table 2 – Perception of the risk impact

Continue...

Risk propositions	Semantic differential					QT	Median	Df	Cf	Degree of the proposition agreement	μ2	μ1	Value interpretation
	VLR	LR	N	R	VR								
Economic													
Economics	0	0	4	7	12	23	VR	2,0	21,0	91,39	0,0870	0,9139	A very strong agreement
Financial													
Financial	0	3	0	6	14	23	VR	3,0	20,0	86,96	0,1304	0,8696	Substantial agreement
Localization													
Localization	0	1	8	4	10	23	R	5,0	18,0	78,26	0,2174	0,7826	Moderate agreement
Design and Technical													
Architecture, structural, electric and hydraulic, compatibilization, fire plan	0	0	6	9	8	23	R	3,0	20,0	86,96	0,1304	0,8696	Substantial agreement
Construction													
Contractors, subcontractors and suppliers	0	2	6	8	7	23	R	5,0	18,0	78,26	0,3043	0,6957	Moderate agreement
Technical	1	1	5	7	9	23	R	4,5	18,5	80,43			Substantial agreement
Construction site and layout	0	4	10	4	5	23	N	9,0	14,0	60,87			Low agreement

Table 2 – Perception of the risk impact

Continue...

Risk propositions	Semantic differential					QT	Median	Df	Cf	Degree of the proposition agreement	μ2	μ1	Value interpretation
	VLR	LR	N	R	VR								
Construction													
Geography and weather	0	9	7	3	4	23	N	12,5	10,5	45,65	0,3043	0,3043	Insignificant disagreement
Safety	1	4	7	6	5	23	N	8,5	14,5	63,04			Low agreement
Agreements	0	2	3	9	9	23	R	3,5	19,5	84,78			Substantial agreement
Performance	2	1	6	8	6	23	R	6,0	17,0	73,91			Moderate agreement
External													
Agreements factors	0	2	5	8	8	23	R	4,5	18,5	80,43	0,3913	0,6087	Substantial agreement
Act of God	0	1	7	5	10	23	R	4,5	18,5	80,43			Substantial agreement
Social aspects	2	5	10	5	1	23	N	12,0	11,0	47,83			Negligible disagreement
Politics aspects	5	3	8	4	3	23	N	12,0	11,0	47,83			Negligible disagreement
Environmental	1	6	6	5	5	23	N	10,0	13,0	56,52			Negligible agreement
Politics and regulatory visibility	4	4	6	4	5	23	N	11,0	12,0	52,17			Negligible agreement

Table 2 – Perception of the risk impact

Risk propositions	Semantic differential					QT	Median	Df	Cf	Degree of the proposition agreement	μ2	μ1	Value interpretation
	VLR	LR	N	R	VR								
Organizational													
Organizational	0	7	7	4	5	23	N	10,5	12,5	54,35	0,4565	0,5435	Negligible agreement
Management													
Management	1	2	8	9	3	23	R	7,0	16,0	69,57	0,3043	0,6957	Low a greement
Commercial													
Financial	1	2	5	5	10	23	R	5,5	17,5	76,09	0,2754	0,7246	Moderate agreement
Planning, monitoring and control	2	0	9	7	5	23	R	6,5	16,5	71,74			Moderate agreement
Lands, properties and statutory authorization	2	2	6	8	5	23	R	7,0	16,0	69,57			Low agreement

Source: Sanches *et al.* (2011) and research data

Notes. VLR: Very Little Relevant; LR; Little Relevant; N; Neutral; R; Relevant; VR; Very Relevant; QT; Quantity; Df; Disagreements of the factor; Cf: Factor concordant; μ2: Disbelief that the values are proper degree; μ1: Belief that values are proper degree.

Behling & Lenzi, 2019). The execution of construction work demands a high volume of planning, not only of the work itself but of the business and everything that entails the action of building. Analyzing the responses it was observed that although there is awareness of the need for management processes concerning the technical aspects of the work on the part of the builders, the action itself is often symbolic.

Probing this analysis, the projects' technical management generally occurs according to a physical-financial schedule. This, in its turn, is elaborated based on information available regarding the estimated cost for materials and labor, deadline, and project design (which determines the construction standard) as stated by Conterato (2018), Roghanian et al. (2018), and Regis and Cardoso (2021). As these authors claim, this practice was found to be universally applied by participants in this study. More than 50% of the respondents stated that their strategies for reducing risk perception are overpricing the items presented in the physical-financial schedule. An essential aspect of this tool is the limitation related to the information update, given that for such calculations to occur, the construction managers require a specific period that they do not always have. Therefore, some proactive steps in response to risk events, albeit intuitive, are noticeable. Regardless, it was also observed that even though some measures are taken, they relate to financial questions, neglecting other forms of planning that could contribute to real risk mitigation.

As for the perception of the risk impact on the construction category, a weak agreement regarding propositions (μ_1=0.6957 on average) was observed. However, analyzing each item factors related to labor (μ_1=0.7826) and performance (μ_1=0.7391) showed moderate agreement. At the same time, technical (μ_1=0.8043) and contractual (μ_1=0.8478) questions presented substantial agreement, indicating that the respondents perceived these latter issues as more significant risks.

This sector relies intensively on labor to successfully implement their projects. Even so, it is a field dominated by informality concerning risk and project planning or the profile for personnel hiring. According to the interviews, poor training is a severe

problem for developing projects, making a relevant impact on the enterprise. On the other hand, the information collected indicates that, generally, there is no investment in training workers. On being questioned about the matter, one of the participants attributed their disinterest in training to an absence of internal metrics to show that a trained and, consequently, a more expensive professional would bring greater productivity to the project.

Even with this presents a significant risk factor, the contractors hire unskilled professionals to fulfill financial planning goals to the detriment of quality, indicating a propensity towards risk-taking. Once again, the behavior identified in the sample analyzed confirms the propositions in the literature, for example, that of Catelan and Cunha (2023). Additionally, at this point, a paradox is perceived. This industry is based mainly on the triad of cost/schedule/quality, the basic structure of the physical-financial schedule. Thus, based on this research findings, it is possible that, as long as the financial aspect is not affected, issues such as the quality of the service provided and fulfillment of the projected timeline remain secondary.

In dealing with the impact of risks categorized as external, it was found that only those resulting from contractual factors and risks related to unforeseeable events were indicated as relevant (μ_1=0.8043 each), the others being understood as neutral. Such an interpretation gains force when observing the general average of μ_1=0.6087, which indicates only a weak agreement regarding propositions being risk factors with significant impact.

Be that as it may, it is in this category that the two most significant risk factors appear. According to the responses collected, CCI managers' most significant problems are excess bureaucratization and political and economic instability (red group, in Appendix 1). However, in interviews, the contractors were not unanimous upon being invited to discuss whether these factors are a greater risk for their projects. For them, bureaucracy and political instability are risk factors, but they are not the most pressing in their daily routines. For the construction managers, these are matters of simple

management. The information necessary for mitigating risks of this nature is available from the corresponding public agencies, only lacking administrative organization in the formalization and legalization of the projects.

There is a debate within the academic literature in which contractors cannot fully understand bureaucratic procedures. Consequently, their planning and control suffer from inconsistencies, much of it stemming from a lack of awareness of tools and methods that could be helpful in their daily operations (Manning & Messner, 2008; Ekung et al., 2020; Kumar & Narayanan, 2020; Senthil & Muthukannan, 2021). Therefore, their aversion to bureaucracy eventually becomes a risk, given that the blind spots caused by such lack of planning are, frequently, irremediably harmful. Regarding political and economic instability, the interviews only reinforced the data collected in the questionnaire. It proved to be an essential point of tension for the contractors. Such concerns are well-grounded, given that the CCI is part of the bedrock of the economy and is affected by significant macroeconomic instabilities. This profile of economic volatility means that managers are correct in their perception regarding this risk factor.

The perception of the impacts of the organizational risk category was neutral, with a negligible agreement that such events have harmful effects on projects (μ_1=0.5435). In the management category, a weak agreement was observed regarding the relevance of its impact capacity (μ_1=0.6957). Hence, it is inferred that the perception concerning the importance of management, not only for RM, is potentially weak among the participants in this research. It reinforces the criticism that management tools are implemented only symbolically, without genuine efforts to implement them and improve the organizational capabilities. What was noticed is that, often, contractors are misinformed, believing that formulating physical-financial schedules, reactive plans, and short-term outlines for projects are sufficient management tools for all aspects of their business.

Regarding the steps taken when faced with risk, 82.6% of the participants reported not using any RM software. The same percentage also stated that they did

not use probabilistic analysis in their planning processes. Such characteristics evidence the deliberate practice of intuitive RM, reinforcing the hypothesis of administrative unpreparedness of the contracting parties. At this point, what was observed in the sample is a movement contrary to that suggested by the risk literature in CCI, which strongly proposes the use of formal RM tools (Siraj & Fayek, 2019; Shibani et al., 2022) to facilitate the identification and management of events (identification, evaluation, treatment, and control) in a cyclical and uninterrupted way (Calôba & Klaes, 2018). For the survey participants, this is not a point that needs attention. As they are the categories with the greatest adherence to business management, it is surprising that they have so little importance for the builders (and partners) in the context of risk analysis. In this sense, it is understood that the propositions of Hanioglu (2022) about the aversion to administrative procedures of CCI managers are present and are confirmed in the analyzed group.

The last category, related to commercial aspects, presented an average agreement of μ_1=0.7146, with relevant adherence and moderate agreement regarding financial risks (μ_1=0.7609) as well as planning, monitoring, and control (μ_1=0.7174); and weak agreement regarding lands, property, and statutory authorization risks (μ_1=0.6957). This perception follows the theory of Gitman (1997) and Shibani et al. (2022), which highlighted that rationalizing decision-making about risks and their financial impacts on the projects is considered more important.

5 FINAL CONSIDERATIONS

This study aimed to understand the perception of CCI managers about RM in their projects and businesses, based on a case study in the city of Volta Redonda-RJ. The observed results showed that the perception of the need for and importance of RM for contractors is, despite being recognized, superficial, receiving attention only when financial losses are identified. This behavior refutes part of the literature on RM, its importance, and the need for formalization and full attention to the subject; however,

it aligns with the literature that argues that informality and intuition are the main management tools in the CCI, including risk. This is the main theoretical contribution of the research, to be confirmed and comprehended in future studies.

Following the literature, we understand that the analyzed subjects have a security and control posture toward clients when contracting the project, demonstrating a relatively high appetite for risk. However, because their mitigation strategies are mainly based on the overpricing of items in the physical-financial schedule when risk events occur and fatally exceed the initial financial forecast, there is an aversion to the effect of risk, transferring it to the customer in the form of delays and extra costs. This finding is a contribution to the RM literature at CCI and a contribution to the managerial practices also.

Regarding research limitations, despite the findings covering more than half of the observed population, we understand that it is impossible to generalize them. The CCI possibly has different characteristics according to the size of the companies and location. However, in practice, the results of this study are a red flag for industry leaders and associative entities, especially those in the analyzed region, and for academy and industry entities. Risk management is not a luxury and managers cannot neglect or treat based only on intuition. Re-education actions regarding the subject, the presentation of valuable tools, and the positive returns RM brings to products and businesses are needed.

For future work, we suggest expanding the study to other cities and regions in the country, observing the differences between the RM in different company sizes. We understand the need to explore if there are no resources for RM in companies due to the wrong resources allocation strategy; or if the lack of resources results from the lack of risk management. Also, in-depth case studies in the companies measuring the financial impacts of inadequate RM can improve the comprehension of this phenomenon.

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1. Definition of research problem	√	√	√		
2. Development of hypotheses or research questions (empirical studies)	√		√		
3. Development of theoretical propositions (theoretical work)					
4. Theoretical foundation / Literature review	√	√	√	√	√
5. Definition of methodological procedures	√		√	√	√
6. Data collection	√				
7. Statistical analysis	√				
8. Analysis and interpretation of data	√		√		
9. Critical revision of the manuscript	√	√	√	√	√
10. Manuscript writing	√				

Conflict of Interest
The authors have stated that there is no conflict of interest.

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Edited by
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APPENDIX

Appendix – Table of risk factors identified by survey

Continue...

Category	Subcategory	Factors	Indications
Economics		Cost related to the purchase and application of materials	17/23
		Personnel expenses	14/23
		Purchase cost of machinery and equipment	9/23
		Others: Lack of ability to pay customers	1/23
		Behavior of the local and global economy, inflation, exchange rate variation	13/23
		Taxes and fees	11/23
Financial		Financing capacity	13/23
Localization		Availability of labor	15/23
		Topography, soil conditions and weather patterns	13/23
		Logistical access	8/23
		Constructions on existing facilities	7/23
		Buildings in new facilities	7/23
		Construction and environmental permits	16/23
		Local laws and regulations	14/23
		Community acceptance of the project	7/23
Technical and Design	Electric and hydraulic Structural	Incomplete and/or deficient cost and schedule estimation	15/23
		Continuous and unruly design changes	12/23
		Inappropriate and incomplete design	9/23
		Unawareness of land conditions	9/23
		Lack of technique to perform tasks	7/23
		Lack of technical knowledge, little experience	6/23
		Land surveys and incorrect foundations	5/23
	Architectural	Incorrect use of equipment, materials and techniques	4/23
	Compatibilization.	Inaccurate technical bases and errors in structural design	4/23
	Fire plan	Technical research absence	3/23
		Customer return delays	10/23
		Excessive owner involvement in the project creation process	8/23
		Unavailability of use of public services	4/23

Appendix – Table of risk factors identified by survey

Continue...

Category	Subcategory	Factors	Indications
Commercial	financial	Economic recessions	17/23
		Financing	14/23
		High interest rates	7/23
		Exchange rate fluctuations	4/23
		Runaway inflation	2/23
	Planning Mon. Control	Contractor selection procedure	13/23
		Design priorities	9/23
		Project management information systems	7/23
		Design selection procedure	4/23
		Control of the main project issues	3/23
		Insurance	1/23
	Properties and authorizations statutory	Land acquisition	10/23
		Damage to neighboring properties	5/23
		Clear urban zoning	11/23
		Release of regulatory institutions	10/23
		Expropriations	5/23
		Right of way	1/23
		Delays in the land access agreement	1/23
Construction	Suppliers contractors subcontractor	Labor disqualification	17/23
		Lack of training and technical knowledge	16/23
		Labor unavailability	12/23
		Contractor and subcontractor capacity	10/23
		Incompetence for management	10/23
		Inefficiency in project management	11/23
		Failure to respect the company's quality standards	8/23
		Failure to comply with health and safety regulations and responsibilities	8/23
		Equipment breakdowns	6/23
		Unavailability of time to use special materials	3/23
		Inadequate equipment and materials	3/23
		Restrictions on working hours	2/23
		Equipment commissioning	1/23
	Technical	Unexpected costs	16/23
		Low-detail projects	12/23
		Constant changes in work orders	7/23
		Calculation errors in the quantities of work	6/23
		Lack of technical direction	5/23

Appendix – Table of risk factors identified by survey

Continue...

Category	Subcategory	Factors	Indications
Construction	Construction site and layout	Safety	15/23
		Interference between tasks	8/23
		Availability of resources	7/23
		Resource overload	3/23
		Access	7/23
		Public services Availability	2/23
	geography and weather	Topography	11/23
		Geography and soil	7/23
		Insufficient soil tests	5/23
		Unexpected weather conditions	13/23
		Groundwater and land drainage	8/23
	Security	Theft	17/23
		Sabotage	6/23
		Vandalism	8/23
		Corruption	5/23
		Illegal occupations	3/23
		Drug trafficking	2/23
	Management	Extra work	16/23
		Errors in time and cost estimates	14/23
		Delivery delays	12/23
		Payment delays	10/23
		Dependence on a supplier, employee, or product	9/23
		Suppliers' evaluation	6/23
		Contract insolvency	4/23
		Inadequacy in the change request procedure	4/23
	Performance	Low productivity	17/23
		Negligence	12/23
		Task execution failure	10/23
		Accidents	8/23
		Lack of knowledge and skill	7/23
		Unsuitable materials	6/23
		Critical deadlines	6/23
		Labor disputes	1/23

Appendix – Table of risk factors identified by survey

Continue...

Category	Subcategory	Factors	Indications
External	Contractual factors	Low definition and little project documentation	11/23
		Inappropriate schedule	10/23
		Late influence on changes	7/23
		Negligence to new stakeholders	2/23
		Quality expectations (from the customer) higher than those documented	15/23
	Act of God	Economic and political instability	20/23
		Acts of God	16/23
		Market changes	13/23
		Adverse climates	10/23
		Natural calamities	10/23
		Regulation changes	9/23
		Strikes	9/23
	Political	Distorted public perception	13/23
		Citizens' interests	9/23
		Negative public exposure	2/23
	Environmental	Hazardous waste, noise, contamination	10/23
		Unexpected regulations	10/23
		Environmental impact statements	8/23
		Preservation of historical or biological heritage	2/23
	Visibility politics and regulation-tions	Excessive bureaucratization	22/23
		Law changes	10/23
		Political and environmental pressures	6/23
		Justice Obstructions	4/23
		Political sensitivity	4/23
		Vulnerability of political support	3/23
		Statutory requirements or authorizations from regulatory institutions	3/23
Organizational		Employees and partners' attitudes	12/23
		Staff inexperience	11/23
		Priority changes	11/23
		Insufficiency of resources	8/23
		Organizational culture	6/23
		Complexities in internal approvals	4/23
		Inconsistent goals	4/23
		Disagreement with goals	2/23

Appendix – Table of risk factors identified by survey

Conclusion

Category	Subcategory	Factors		Indications
Management		Insufficient planning time		12/23
		High staff turnover		11/23
		Insufficient resources		11/23
		Inexperience of staff		8/23
		Resource availability		6/23
		Unforeseen workload		5/23
		Poorly defined project purpose		4/23
		Overloaded portfolio		3/23
		Incomplete identification of interested parties		2/23
		Inadequate claim procedures		1/23

Source: Developed by the authors