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A SYSTEMATIC REVIEW OF RISK MANAGEMENT IN PROJECTS

UMA REVISÃO SISTEMÁTICA DO GERENCIAMENTO DE RISCOS NO GERENCIAMENTO DE PROJETOS

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Abstract: The purpose of this article is to examine the literature on risk management in projects and to provide a robust and structured literature review on risk sources in project management. We developed a systematic review and we found 817 articles on the data bases. We selected 68 articles. Results show 538 sources of risk in projects. We categorized these sources on 25 constructs. This research helps project managers to identify risks prior to the start of the project; and allows to develop appropriate measures to reduce or mitigate risks at an early stage of a project.

Keywords: Project Management. Risk Management. Risk Sources. Systematic Review; Telecommunications.

Resumo: O objetivo deste artigo é examinar a literatura sobre gerenciamento de riscos em projetos e fornecer uma revisão de literatura robusta e estruturada sobre fontes de risco no gerenciamento de projetos. Foi realizada uma revisão sistemática da literatura e encontrados 817 artigos. 68 artigos foram selecionados. Os resultados mostram que existem 538 fontes de risco em projetos. Essas fontes foram agrupadas em 25 categorias. Esta pesquisa auxilia os gerentes de projetos a estimar os riscos antes do início de um projeto e permite desenvolver medidas adequadas para diminuir ou mitigar os riscos em um estágio inicial de um projeto.

Palavras-chave: Gerenciamento de riscos. Gerenciamento de projetos, Fontes de risco.

1 INTRODUCTION

A project is a unique, complex and connected sequence of activities to reach a goal or purpose. It should be ended on a deadline, within a defined budget and according to the technical specification to attend the requirements of clients (PMI, 2013)

Project risk management includes the planning, identification, analysis, response planning, and risk control processes of a project (PMI, 2013). The risk analysis includes the management of the likelihood and impact of positive and negative events.

The project management area involves many organizational functions and sources of risk. Projects have high levels of uncertainty due to tight timelines, inadequate or uncertain budgets due to requirements that can change frequently (ZWIKAEL; AHN, 2011). Then, risk management has developed rapidly in recent decades as an integral part of project management (DEL CAÑO; DE LA CRUZ, 2002; SÖDERLUND; MAYLOR, 2012)

However, some studies indicate that the risk management is still rarely used in the routine of projects, even in complex projects (RAZ, SHENHAR; DVIR, 2002; ZWIKAEL; SADEH, 2007). Therefore, the following research questions are considered: (Q1) what are the sources of risk in project management? (Q2) What are the methodologies to assess risks?

By answering these questions, this research helps project managers to identify risks prior to the start of the project; and allows to develop appropriate measures to reduce or mitigate risks at an early stage of a project. The purpose of this article is to examine the literature on risk management in projects and to provide a robust and structured literature review on risk sources in project management.

We present in the following section a theoretical background on project risk management. In addition, the sources of risk in projects and the methodologies for project risk analysis are discussed. Then, in the third section, we present the methods for the development of the systematic literature review. Subsequently, we reviewed and discussed the selected articles. Finally, we present the conclusions, limitations of the article, and recommendations for future research.

2 THEORETICAL BACKGROUND

Risks can affect the project life cycle, costs, financial performance and strategic objectives (THAMHAIN, 2013). Moreover, stakeholders are increasingly demanding project risk management to protect themselves against financial or legal consequences (FANG; MARLE, 2012). Therefore, risk management is crucial and indispensable for project success, as it can prevent potential problems.

Kerzner e Saladis (2009) presents that the project risk is defined as a measure of the probability and consequence of the project goal does not be achieved. Chapman and

Ward (2004) defined “risk efficiency” as the minimum risk level for a specific level of expected performance, since risk in projects cannot be eliminated.

Zwikael e Ahn (2011) argue that risk management reduce levels of risk by identifying events and developing response plans to monitor the execution of projects.

The Project Management Body of Knowledge (PMBOK) is a reference most popular to manage risk of projects. Although PMBOK is effective in identifying resources, tools and techniques and results, each project needs a proper application to manage risks (PMI, 2013). In addition, Shenhar (2001) and Marcelino-Sádaba, Pérez-Ezcurdia, Echeverría Lazcano *et al.* (2014) argue that project management and risk methodologies cannot be standardized for all types of projects but must be adapted to the nature of the objectives and uncertainties of each project.

The identification of risks in projects is an evaluation process of the risks that can affect the project and to find the characteristics of them. The main benefit of this process is the documentation of the risks to provide the project team with knowledge of anticipating events. It is an ongoing process as new risks may arise or become evident during the project life cycle (PMI, 2013).

Even if project management is in more common activities, such as a budget or timetable, several risk factors may exist. Additionally, control of individual risk factors may not be effective because of the causal ambiguity. Risk factors are often grouped into categories according to related themes (BARKI, RIVARD; TALBOT, 1993). And individual control measures can be effectively applied in one or more categories of risk, rather than treating each individual factor (ADDISON; VALLABH, 2002).

Sources of risk such as technology, project requirements or experience may have multiple related risk factors. Risk categories (also called risk dimensions or risk components) can provide a broader framework for thinking about which risks may threaten a specific project, rather than simply working with a predefined checklist of specific factors. Categories may also represent target areas for the application of risk control strategies (BANNERMAN, 2008).

Some studies categorize risks according to their perceived source (DEMARCO; LISTER, 2003; MCKEEN; SMITH, 2003; FANG; MARLE, 2012; KUŠAR, RIHAR, ŽARGI

et al., 2013; THAMHAIN, 2013). For example, Thamhain (2013) found over 600 situations and conditions related to project risk in empirical research. Thamhain (2013) defined 14 risk classes that were grouped based on their root causes.

The most common risk management approach found in the literature and practice is process models (BANNERMAN, 2008). Process models specify stepwise tasks for managing risks, for example, actives as risk identification, analysis, response and control. The models also specify how these activities should be sequenced to effectively manage the risk and, less frequently, may also suggest tools and techniques to use in individual steps to assist in the risk management process.

A model is a simplified representation or abstraction of reality that describes, reflects or replicates a real event (MEREDITH, 1993). Quantitative model "*are based on a set of variables that vary over a specific domain, while quantitative and causal relationship have been defined between these variables*" (BERTRAND; FRANSOO, 2002, p.242). Models are classified in normative, descriptive and prescriptive. "*Normative models are used by philosophers, economists and scientist to explorer how they should made decision*" (FRENCH, MAULE; PAPAMICHAIL, 2009) under a rational behavior (Raiffa, 1994). "*Descriptive models are used by phycologists to explain how people do decisions making"*, which theoretical base was influenced from Simon's studies about limited capacity of peoples. Prescriptive models are an interaction of the both previous models, including values, preferences, beliefs and judgements of peoples that are consistent a normative theory (FRENCH, MAULE; PAPAMICHAIL, 2009).

We found influent models in project risk management. Marcelino-Sádaba, Pérez-Ezcurdia, Echeverría Lazcano *et al.* (2014) concentrated in phases of project life cycle and (KUŠAR, RIHAR, ŽARGI *et al.*, 2013) e Ou-Yang e Chen (2017) also present models with phases of the strategy, identification, analysis, responses and control of risk.

Rodney, Ducq, Breysse *et al.* (2015) argue that many techniques for managing project risk have been long overdue. However, these techniques do not integrate all risk factors and all project processes. In analyzing the methods and models available in the literature, the proposal by Marcelino-Sádaba, Pérez-Ezcurdia, Echeverría Lazcano *et al.* (2014) integrating all the design and use activities as the basis for the life cycle phases of

PMI, but also coming from some procedures such as that proposed by Da Nóbrega, Fenner e Lima (2014).

According to Shenhar (2001) project management and risk management methodologies cannot be standardized for all types of projects, but must be adapted to the nature of the objectives and uncertainties of each project. We notice that the best option to perform risk management is to use the data flow diagram to identify the risks of the PMI (2013) and to adapt it to the characteristics of the project.

Additionally, some techniques and tools are used for risk assessment and its level of application. For example, the Analysis of Failure Mode and Effect (FMEA) has a strong application for risk identification, consequence analysis, probability, level and risk assessment. Markov analysis can be used only for risk identification and risk consequence analysis. Risk management standard 2002 also presents techniques and methods used to identify and analyze risks, which can be applied in a general context of organizations (SANCHEZ, ROBERT, BOURGAULT *et al.*, 2009).

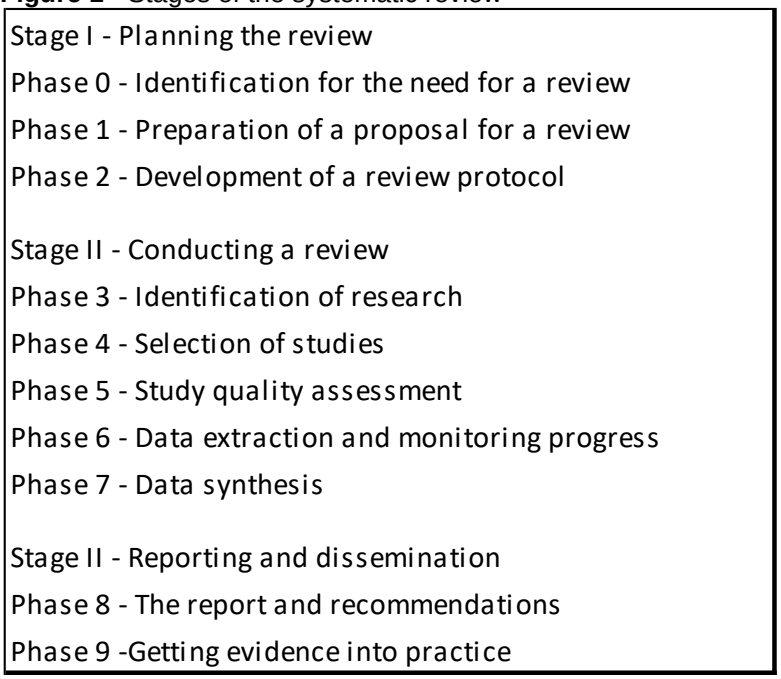
3 LITERATURE REVIEW METHODOLOGY AND PROCEDURES

Literature reviews have the objective of summarizing existing research by identifying patterns, themes and issues; and helping to identify the conceptual content of the field, helping contribute to theory development (SERRADOR, 2013). Levy e Ellis (2006) define a literature review as sequence of steps to collect, comprehend, analyze, synthesize and evaluate published research in order to provide a firm foundation to a topic. The output of this review process should be to demonstrate something new to the overall body of knowledge. Literature reviews have been increasingly popular among researchers as they can capture the trends of the past and at the same time indicate the future of a research field. As one example of its value, some of the most popular and highly cited articles in first-tier operations management journals are literature reviews (such as GOVINDAN, RAJENDRAN, SARKIS *et al.*, 2015).

Following the systematic approach of Tranfield, Denyer e Smart (2003) (Figure 1). First, a primary search was conducting using the protocol described in Table 1. This primary research contributed to establishing our research questions, the basic terminology

and key words for this article. Our primary references were Thamhain (2004); Thamhain (2013). In the second stage, we identified the knowledge fields, keywords and the criterion of inclusion and exclusion articles. Then, we summarized the data on analyses categories. Finally, in the third stage, report and dissemination, we put forward the results and a discussion by analyzing the findings of the literature review.

Figure 1 - Stages of the systematic review



Source: Tranfield, Denyer and Smart (2003, p. 214)

Table 1 - Research Protocol

Language:	English-only
Date range:	The survey has the data range defined from 2007s, to we work with the most recent articles in the area. The final updated set of data for the review was compiled in November 2017, so papers published after this date are not included.
Search fields:	Search terms were applied to Titles, Abstracts and Keywords.
Search terms:	Keywords used on SCOPUS and specific journals: "risk management" AND "project management"
Exclusion Criteria:	a) Semantic Relevance
Criteria:	b) Relevance to the research problem

Source: Created by the author

We selected the Scopus database and found scientific journals that contained a majority of published on project risk management: International Journal of Project Management, Journal of Modern Project Management, Management and Production Engineering Review, Project Management Journal. Initially, 817 hits in total were found, as shown in Table 2, indicating the number of articles found after the search and the number of articles selected. And we selected 68 articles. The largest number of articles selected were those found in the Scopus database (51). 9 articles published are from International Journal of Project Management.

Table 2 - Search results

Keywords used on SCOPUS and specific journals	"risks management “and "Project management"	
	Search results (nº of articles)	**number of selected articles**
BASE SCOPUS	711	51
International Journal of Project Management	84	11
Journal of Modern Project Management	5	2
Management and Production Engineering Review	2	2
Project Management Journal	15	2
TOTAL	817	68

Source: Created by the author

4 ANALYSIS AND FINDINGS OF THE LITERATURE REVIEW

We identified 538 sources of risk in projects through analysis of the 68 selected articles. We categorized these sources on 25 constructs: 1) budget, bidding and financial problem; 2) bureaucracy / law / government rules and regulations; 3) team production capacity / team size; 4) customers or risk of demand; 5) change of scope / goals; 6) inadequate communication; 7) conflicts; 8) contracts; 9) culture; 10) delays and schedule; 11) design / project; l2) environmental risk; 13) inadequate change management; 14) project management methodology; 15) documentation and management of processes; 16) project leader-ship; 17) technology required; 18) risks related to quality; 19) reputation of the company; 20) contingency risk; 21) security; 22) stakeholders; 23) storage / stock capacity; 24) supplier; and 25) skills / experience / efficiency of the team (Table 3).

Categories of 1) budget, bidding and financial problem; (2) design / project; and (3) team production capacity / team size are among the 3 categories with the highest number of risk sources related.

Table 4 shows the risks identified and the 68 articles analyzed. Additionally, we grouped the risk in two categories: internal risks and external risks (Figure 2). El-Sayegh (2008) defined internal risks as those that are related to the project and are generally under the control of the project management team. And external risks are those that are outside the control of the team (WANG; CHOU, 2003; FANG, LI, FONG *et al.*, 2004). Complementary, Aleshin (2001) stated that "internal risks are initiated within the project while external risks originate due to the project environment

Table 3 – Constructs of the first order and the number of sources of risks found

	25 Constructs of the First Order	Sources of Risks (Quantity)	%
1	Budget, Bidding and financial problem	75	13,9%
2	Design/Project	60	11,2%
3	Team skills / experience / efficience	55	10,2%
4	Delays / Schedule	45	8,4%
5	Bureaucracy /law/rules and regulations of government	38	7,1%
6	Leadership on project	38	7,1%
7	Environmental risk	34	6,3%
8	Change of scope/goals	24	4,5%
9	Capability team production / Team Size	23	4,3%
10	Clients or Demand risk	22	4,1%
11	Safety	18	3,3%
12	Supplyer	18	3,3%
13	Inadequate Communication	17	3,2%
14	Conflicts	10	1,9%
15	Documentation or process management	10	1,9%
16	Contracts	9	1,7%
17	Inappropriate change management	8	1,5%
18	Quality related risks	8	1,5%
19	Necessary technology	6	1,1%
20	Reputation of company	5	0,9%
21	Project management methodology	4	0,7%
22	Risk of contingency	4	0,7%
23	Stakeholders	3	0,6%
24	Culture	2	0,4%
25	Storage / Stock Capacity	2	0,4%

Source: Created by the author

From an examination of these tables (Tables 3 and 4) it becomes apparent to organize possible project risks in a similar way to the project analytical framework. PMI (2013) suggests the development of risk analytical framework to visualize the risk categories. Different types of framework are appropriate to specific projects. Figure 2 presents the 25 constructs of risk of this research. They were divided in internal and external risks. We categorized the internal risks in technical, lawful, project management and commercial. External risks were categorized in pollical, client, supplier and environmental.

Figure 2 – Sources of risks separate in internal and external risks

Riscos Externos				Riscos Internos				
Políticos	**Clientes**	**Fornecedores**	**Ambientais**	**Técnicos**	**Organizacional**	**Legais**	**Gerenciamento de Projeto**	**Comercial**
Burocracia / lei / regras e regulamentos do governo	Clientes ou risco de demanda	Fornecedor	Risco ambiental	Tecnologia necessária	Reputação da empresa	Contratos	Liderança em projeto	Orçamento, licitação e problema financeiro
	Mudança de escopo / metas			Competências / experiência / eficácia da equipe	Cultura		Metodologia de gerenciamento de projetos	
				Segurança			Documentação ou gerenciamento de processos	
				Riscos relacionados à qualidade			Stakeholders	
				Design / Projeto			Comunicação inadequada	
				Risco de contingência			Capacidade de produção da equipe / Tamanho da equipe	
				Capacidade de armazenamento / estoque			Conflitos	
							Atrasos / Cronograma	
							Gerenciamento inapropriado de mudanças	

Source: Created by the author

Technical risks refer to events such as: technology to meet a project, competence, experience and effectiveness of the work team, safety (risks to workers), risks related to quality, risks of project development (planning or some design error). Project), contingency risks (related to lack of maintenance) and storage or stock capacity. Organizational risks are related to employee culture and to the company's reputation. Lawful risks concern closed contracts.

Table 4 – Sources of risks suggested by the literature (continue)

Risks	Categories	Authors
1	Budget, Bidding and financial problem	Choudhry, Aslam e Arain (2014); Elzamly e Hussin (2015); Rodney, Ducq, Breysse *et al.* (2015); Doubravskỳ, Doskočil e Dohnal (2016); Guerrero-Liquet, Sánchez-Lozano, García-Cascales *et al.* (2016); Liu e Yuliani (2016); Stojanović (2016); Ahmadi, Behzadian, Ardeshir *et al.*(2017)
2	Bureaucracy /law/rules and regulations of government	Tang, Qiang, Duffield *et al.(*2007); Thamhain (2013); Choudhry, Aslam e Arain (2014); Lee e Schaufelberger (20140; Rao, Zhang, Shi *et al.(*2014); El-Sayegh e Mansour (2015)
3	Capability team production / Team Size	Tang, Qiang, Duffield *et al.(*2007); Thamhain (2013); Neves, Da Silva, Salomon *et al.* (2014); El-Sayegh e Mansour (2015); Doubravskỳ, Doskočil e Dohnal (2016); Hwang (2016)
4	Clients or De-mand risk	(Chang Lee, Lee e Li (2009); Tsai e Yang (2009); Arashpour, Wakefield, Lee *et al. (*2016); Liu e Yuliani (2016); Perrenoud, Smithwick, Hurtado *et al.(*2016)
5	Change of scope/goals	(Thamhain (2013); Neves, Da Silva, Salomon *et al.(*2014); Rao, Zhang, Shi *et al. (*2014); Liu, Meng e Fellows (2015); Yim, Castaneda, Doolen *et al.* (2015); Arashpour, Wakefield, Lee *et al. (*2016); Bozorg-Haddad, Orouji, Mohammad-Azari *et al. (*2016)
6	Inadequate Communication	Tang, Qiang, Duffield *et al.(*2007); Hu, Zhang, Ngai *et al.(*2013); Thamhain (2013); Choudhry, Aslam e Arain (2014); Arashpour, Wakefield, Lee *et al.* (2016); Liu e Yuliani (2016)
7	Conflicts	Bannerman (2008); Chang Lee, Lee e Li (2009); Tsai e Yang (2009); Arashpour, Wakefield, Lee *et al.* (2016); Liu e Yuliani (2016); Perrenoud, Smithwick, Hurtado *et al.(*2016)
8	Contracts	Tang, Qiang, Duffield *et al.* (2007; Hu, Zhang, Ngai *et al.* (2013); Thamhain (2013); Liu, Meng e Fellows (2015); Yim, Castaneda, Doolen *et al.* (2015); Arashpour, Wakefield, Lee *et al.* (2016); Liu e Yuliani (2016)
9	Culture	El-Sayegh e Mansour (2015) ; Jamshidi, Ait-Kadi e Ruiz (2017)
10	Delays / Sched-ule	El-Sayegh (2008); Choudhry, Aslam e Arain (2014); Lee e Schaufelberger (2014); Neves, Da Silva, Salomon *et al. (*2014); El-Sayegh e Mansour (2015); Hwang, Zhao, See *et al.* (2015); Liu, Meng e Fellows (2015); Arashpour, Wakefield, Lee *et al. (*2016); Doubravskỳ, Doskočil e Dohnal (2016)
11	Design/Project	Bannerman (2008); Arena, Azzone, Cagno *et al. (*2014); Choudhry, Aslam e Arain (2014); Rao, Zhang, Shi *et al.* (2014); El-Sayegh e Mansour (2015); Elzamly e Hussin (2015); Arashpour, Wakefield, Lee *et al.* (2016); Liu e Yuliani (2016); Perrenoud, Smithwick, Hurtado *et al.* (2016); Rezazadeh Kermani e Momeni (2016)
12	Environmental risk	Choudhry, Aslam e Arain (2014); El-Sayegh e Mansour (2015); Hwang, Zhao, See *et al.* (2015); Liu, Meng e Fellows (2015); Guerrero-Liquet, Sánchez-Lozano, García-Cascales *et al.* (2016); Rezazadeh Kermani e Momeni (2016)
13	Inappropriate change manage-ment	Chang Lee, Lee e Li (2009); Dey, Clegg e Bennett (2010); Hu, Zhang, Ngai *et al.* (2013)

Table 4 – Sources of risks suggested by the literature (Conclusion)

Risks	Categories	Authors
14	Project management methodology	Tang, Qiang, Duffield *et al.* (2007); Hu, Zhang, Ngai *et al.* (2013); Neves, Da Silva, Salomon *et al.* (2014); Liu e Yuliani (2016)
15	Documentation or process management	Tang, Qiang, Duffield *et al.* (2007); Hwang, Zhao, See *et al.* (2015); Yim, Castaneda, Doolen *et al.* (2015); Liu e Yuliani, (2016)
16	Leadership on project	Bannerman (2008); Arena, Azzone, Cagno *et al.* (2014); Choudhry, Aslam e Arain (2014); Neves, Da Silva, Salomon *et al.* (2014); Elzamly e Hussin (2015); Liu e Yuliani (2016); Rezazadeh Kermani e Momeni (2016); Firmenich (2017)
17	Necessary technology	Hu, Zhang, Ngai *et al.* (2013); Arena, Azzone, Cagno *et al.* (2014); Choudhry, Aslam e Arain (2014)
18	Quality related risks	Hwang, Zhao, See *et al.* (2015); Arashpour, Wakefield, Lee *et al.*, (2016); Rezazadeh Kermani e Momeni (2016)
19	Reputation of company	Fang e Marle (2012); Jamshidi, Ait-Kadi e Ruiz (2017)
20	Risk of contingency	Chang Lee, Lee e Li (2009); Arashpour, Wakefield, Lee *et al.* (2016); Guerrero-Liquet, Sánchez-Lozano, García-Cascales *et al.* (2016)
21	Safety	Tang, Qiang, Duffield *et al.* (2007); Lu e Yan (2013); Choudhry, Aslam e Arain (2014); El-Sayegh e Mansour (2015); Perrenoud, Smithwick, Hurtado *et al.* (2016); Galli (2017)
22	Stakeholders	Hwang, Zhao, See *et al.* (2015); Doubravskỳ, Doskočil e Dohnal (2016)
23	Storage / Stock Capacity	Rodney, Ducq, Breysse *et al.* (2015)
24	Supplier	Tang, Qiang, Duffield *et al.* (2007; El-Sayegh (2008); Chang (2015); Hwang, Zhao, See *et al.* (2015); Rodney, Ducq, Breysse *et al.* (2015); Liu e Yuliani (2016); Rezazadeh Kermani e Momeni (2016); Jamshidi, Ait-Kadi e Ruiz (2017)
25	Team skills / experience / efficiency	Bannerman (2008); Fang e Marle (2012); Hu, Zhang, Ngai *et al.* (2013); Arena, Azzone, Cagno *et al.* (2014); Choudhry, Aslam e Arain (2014); Neves, Da Silva, Salomon *et al.* (2014); Rodney, Ducq, Breysse *et al.* (2015); Liu e Yuliani (2016); Rezazadeh Kermani e Momeni, 2016; Stojanović (2016); Jamshidi, Ait-Kadi e Ruiz, 2017)

Source: Created by the author

Project management risks include project leadership, management methodologies, documentation or processes, stakeholders, inadequate communication, production capacity or team size, conflicts, schedule delays, and inappropriate management of changes. Commercial risks involve contractual and legal risks, such as delays in payments, inadequate ordering and financial risks.

Regarding to external risks, the political risks refer to events about the political environmental, rules and regulations of the country where the project is taking place. Environmental risks arise from natural events that threaten the progress of the project. Supplier risks are events that can affect the project schedule due to delays in deliveries. Clients risks may lead to changes in scope or simply problems in customer relationships. The anticipation of these events through the identification of internal or external factors is part of the goal of risk management, which is presented in ISO 31000.

After analyzing the 68 articles selected it is possible to consider that: (a) most tools used in the context of risk management are not applicable to the entire risk management process (BREYSSE, TEPELI, KHARTABIL *et al.*, 2013); (b) relevant methods for identifying, analyzing, assessing and treating risks, such as brainstorming, are not structured; They only deal with qualitative information and are limited by the users' experience (GRIMALDI, RAFELE, CAGLIANO *et al.*, 2012); and (c) Risk is usually addressed regardless of the project and its environment.

Project risk management is carried out independently and is not integrated with all project activities. We note that some methodologies for integrated project risk management have been developed. They are usually based on a temporal representation of the project (PERT, Gantt). Thus, the project within a limited time frame is divided into activities associated with risks. These risks result in additional runtime and cost overhead. Some tools also allow managers to increase the resources allocated to an activity, in addition to reduce the duration of the project. Then, they are not integrated with all activities of the project. Table 5 presents the methods or frameworks for risk management found in the literature. Of the 25 methodologies found, 56% are in the area of civil construction and information technology. There are still gaps in research for risk management in other sectors.

Table 5 – Methods of managing risks suggested in the literature (continue)

Methods of managing risks	Authors	Decision Methods	Area for application of the model	Application of the model
Integrated Method of Project Risk Management	Rodney, Ducq, Breysse *et al.* (2015)	Conceptual model	General areas	Model not applied in practice
Prorisk	Suebkuna e Ramingwong (2011)	Conceptual model	Information Technology	Model not applied in practice
Risk assessment model	Ou-Yang e Chen (2017)	Process model	Construction	Model applied in case study
An Advanced Dynamic Risk Modeling and Analisys in Projects Management	Jamshidi, Ait-Kadi e Ruiz (2017)	Cognitive Map Fuzzy	General areas	Model not applied in practice
Proposed framework of risk management	Ahmadi, Behzadian, Ardeshir *et al.* (2017)	Cognitive Fuzzy Map (AHP)	Construction	Model applied in case study
Project risk management process	Firmenich (2017)	Process model	Construction	Model not applied in practice
Evaluation framework for project vulnerability assessment	Aleksic, Puskaric, Tadic *et al.* (2017)	Cognitive Map Fuzzy	General areas	Model applied in case study
Risk analysis process model and risk management process model	Stojanović (2016)	Conceptual model	Mining Sector	Model applied in case study
Network model of key risks propagation on submarine pipeline project	Zou, Liu, Xu *et al.* (2016)	Network Theory	Marine Engineering	Model applied in case study
Recommended Model for Project Risk Management	Rezazadeh Kermani e Momeni (2016)	Cognitive Map Fuzzy	Construction	Model applied in case study
The framework of the profit risks model	Zhang, Feng e Li (2016)	Decision tree	Construction	Model applied in case study
Technical scheme of the methodology	Guerrero-Liquet, Sánchez-Lozano, García-Cascales *et al.* (2016)	PMBOK Guide Risk Management Tools	Photovoltaic Solar Energy	Model applied in case study
SMACC processes	Taillandier, Taillandier, Tepeli *et al.* (2015)	SMACC multi-agent model	Construction	Model applied in case study
Risk identification process	Da Nóbrega, Fenner e Lima (2014)	Conceptual model	Information Technology	Model applied in case study
Project risk management methodology proposed including activities and documents	Marcelino-Sádaba, Pérez-Ezcurdia, Echeverría Lazcano *et al.* (2014)	Conceptual model	General areas	Model applied in case study

Table 5 – Methods of managing risks suggested in the literature (Conclusion)

Methods of managing risks	Authors	Decision Methods	Area for application of the model	Application of the model
Schedule risk management framework	Rao, Zhang, Shi *et al.* (2014)	Conceptual model	Construction	Model applied in case study
The "Spring model" for ERM	Arena, Azzone, Cagno *et al.* (2014)	Conceptual model	General areas	Model applied in case study
Procedure for risk management of project activities	Berlec, Starbek, Duhovnik *et al.* (2014)	Process model	Automobile Industry	Model applied in case study
Project risk rating: framework	Baccarini e Archer (2001)	Process model	Public Service Area	Applied in several economic projects
The Ishikawa model for identification of project risks	Kušar, Rihar, Žargi *et al.* (2013)	Process model	Mechanical Engineering	Model applied in case study
Process model	Dikmen, Birgonul, Tah *et al.* (2012)	Process model	Information Technology	Model applied in case study
Progressing between maturity models modified based on Risk Management Research and Development Program Collaboration (RMRDPC)	Zou, Chen e Chan (2010)	Model RM3 Web	Construction	Model applied in case study
Risk management framework for the group's ERP implementation	Dey, Clegg e Bennett (2010)	Conceptual model	Commercial area	Model not applied in practice
The TPRM framework	Seyedhoseini e Hatefi (2009)	Process model	Construction	Model applied in case study
MACOM	Chang Lee, Lee e Li (2009)	Conceptual model	Information Technology	Model applied in case study
Holistic conceptual risk model	Zhou, Vasconcelos e Nunes (2008)	Conceptual model	Information Technology	Model applied in case study

Source: Created by the author

5 FINAL REMARKS

The main contribution of this article is the identification of 538 sources of risk that were divided into 25 categories. And we answer our research question RQ1. They may can be useful for future studies to anticipated risks in projects.

Categories of (1) budget, bidding and financial problem; (2) design / project; and (3) team production capacity / team size; (4) delays/schedule; (5) Bureaucracy/law/rules and regulations of government; and (6) Leadership on project represent 57% of the sources of risks in projects and thus appear as the most relevant sources of risk.

By mapping the 25 general constructs into internal and external risks it is possible to analyze that most internal risks are related to project management.

Through the answer to our research question 2 (RQ2), we realize that the methods developed to evaluate the risks are not widely used by practitioners. We have identified theoretical framework that has not yet been applied by practitioners (e.g. Jennifer, 2017). Therefore, there are opportunities for empirical studies in many sectors, due to most empirical studies are concentrated in the area of civil construction and information technology.

Additionally, we could not present the 538 sources of risk identified on this article and they can request for the authors.

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