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COST SIMULATOR FOR RISK MANAGEMENT OF WORK ACCIDENTS

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ABSTRACT

Occupational accidents have recurred since the beginning. Although there has been an effort by regulators and companies to increase safety in the last decades, statistics are alarming and the consequences affect companies, employees and their families, as well as the nation's economy, impacting the whole society. Literature seems unanimous on the benefits of applying security resources, but there is a gap in the composition of these costs — where and how much to apply — in addition to financial measurement. In this sense, the objective of this study is to develop a cost simulation tool to manage occupational accidents risks. It is a descriptive, qualitative research that presents an unprecedented instrument in literature, which brings in its essence singular contributions to the management of work-related accident risk. The model is part of an adaptation of the methodology used to manage risks and disasters, adopted by Civil Protection and Defense in Brazil and in the world, which comprise the stages before, during and after disasters. Cost elements are used, proposing a new classification to be employed in the risk management of work accidents. It culminates in a cost simulator, which allows the manager to balance his finances at each stage of the proposed management cycle. The model was validated in a real case study. It was concluded that the costs of the prevention, mitigation and preparation phases are better than the costs of response and recovery, since it is pain and lives

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that are spared, as well as financial resources. The model allows generalization, since the cost elements can be adapted to the branch of activity of each company. The proposal is to use the new cost classification to manage occupational accident risks.

Keywords: *Risk management. Occupational risks. Cost management. Accidents at work. Cost Simulator.*

1 INTRODUCTION

Changes in organizations' current business environment stem from increased competitiveness and globalization, factors that drive companies to review their policies and strategies to adapt to environments in order to improve their performance and remain in the market (Parente, Luca and Vasconcellos, 2015). In this competitive environment for companies, many managers do not pay enough attention to the work environment. Therefore, they do not perceive the damage to which they expose their employees (Araújo, Santos and Mafra, 2006).

Security, in turn, is a variable inversely proportional to risk because the higher the risk, the lower the security (and vice versa). And as security increases, risks can be reduced. Therefore, all activity must be performed with security assurance and according to norms/resources necessary to perform certain tasks, whether for personal or collective use, since it is important to use equipment correctly in their accomplishment (Ferreira, Souza, Ribeiro, Galdino and Ricci, 2012).

According to Brazilian magazine *Revista Proteção* (2016), statistics in 2015 Brazilian Protection Yearbook (*Anuário Brasileiro de Proteção*) about losses – specifically occupational accidents – indicate that, after a period of successive declines in historic averages, which reached -57.94% in the 1990s, they began to show significant evolution in recent years – an average of +8.95% in the years 2000 and +39.67% in the quadrennium 2010-2013 –. Studies such as those by Iwamoto, Camargo, Tavares and Miranzi (2011), Soares (2012) and Maia (2015), point to an increasing underreporting of these losses.

According to Ferreira *et al.* (2012), in addition to workers, security at work is also of interest to companies and society, since, in addition to personal suffering, injured workers cause expenses to countries' social security system, which start to pay benefits afforded by employees and companies. It should be noted that occupational accidents are a serious public health problem, accounting for 4% of the world's gross domestic product (Hämäläinem, Saarela and Takala, 2009), for 18% of deaths in middle- and low-income countries and 5% in high-income countries (Takala *et al*., 2014).

In Brazil, such accidents account for a third of all outpatient visits to health services, generating costs at the emergency rooms, hospitalizations, rehabilitation and drugs (Ministério da Saúde, 2014). In addition, expenses with retirement and pensions total more than 60% of benefits paid by the Brazilian social security (Santana, Araújo, Albuquerque and Barbosa, 2006) and represent a cost of BRL 71 billion, which is equivalent to almost 9% of the country's wage bill (Pastore, 2011).

Also based on official statistics, more than 80,000 deaths have been recorded in the 1988-2011 period, with at least 2,800 deaths per year, the majority of which due to accidents and diseases considered preventable (Portal do Brasil, 2014). Accidents generate costs. Therefore, the best way to minimize them in companies is still on investing in preventing work accidents and preventing and anticipating facts is the goal of occupational security professionals (Ferreira *et al.*, 2012).

Accidents and work-related illnesses cause pain and suffering to victims, their relatives and coworkers. Costs of these accidents are a burden for any productive activity. However, by means of an adequate evaluation of accidents costs, management can realize that adequate and efficient security programs represent more than expenses and how favorable the intervention of this program in productivity is (Franz, 2006).

Although much physical and mental work has been applied in accident prevention and large sums of resources have been spent in creating methods and devices, accidents continue to occur and challenge efforts, with many lives lost, the causes of which being almost always attributed to human factors (Ferreira *et al*., 2012).

In the current literature, corporate risk management is discussed. Several entities such as Risk Management (RMA), Risk and Insurance Management Society (RIMS), Casualty and Actuarial Society (CAS), in addition to the Committee of Sponsoring Organizations of the Treadway Commission (COSO), consider that the concept of risk management deserves to be extended to corporate vision and not analyzed in an individualized manner by type of risk and/or area of the company. All types of risks present shall lead to efficient management and in this context arises the expression known in the literature as Enterprise Risk Management (ERM) (Ching, 2011).

The nomenclature of costs incurred by accidents that have taken place or by risks that they take place is somewhat diversified. Benite (2004) and Franz (2006) approach them as "prevention costs" (or "security costs") and "accident costs" ("cost of non-security"). Lopes, Queiroz and Leonardi (2010) also present the concepts of "insured cost" and "uninsured cost." Authors Liu, Hwang and Liu (2009) adopt the terms "insured" and "uninsured" to refer to direct and indirect costs.

As for the model of risk and disaster management adopted by the Civil Protection and Defense for the University center for studies and investigations on disasters (*Centro Universitário de Estudos e Pesquisas Sobre Desastres*) [CEPED/UFSC] (2014), risk management comprises the process of prevention, mitigation, preparedness, response and recovery. It was not possible to identify in the national literature studies on occupational risks management that approach this process.

In view of the above and considering the importance of strategic cost management in risk control and the importance of consolidating a methodology to simulate costs in different phases of management processes, the research objective is to develop a cost simulation tool for risk management.

The research justification is in line with the issues raised, related to the burden generated by work accidents for companies. Studies identified in the literature do not yet offer sufficiently developed alternatives that allow managers to define their work risk management policies. Bonfante, Eyerkaufer and Dallabona (2017) point to two aspects related to work accident risk management that lack theoretical and practical contributions: initiatives beyond compulsory occupational security and the development of appropriate risk management methodologies. This research focuses on the second aspect raised by the authors.

The relevance of the study is not restricted to the field of business management because these are lives that leverage the country's economy. For Fabre and Eyerkaufer (2018), risk management requires policies to join and organize efforts, which depart from public entities for integration of other sectors of society as individuals or legal entities. In this sense, it is important to identify the costs of occupational accidents to provide technical support to new public policies for the benefit of workers and entrepreneurs in promoting social welfare.

2 RISK MANAGEMENT

Risk management involves structured management control activities and internal controls (Dalvesco, Fernardes and Roncon, 2014). For the International Association of Insurance Supervisors [IAIS], (2008), risk management is a process of identification, measurement, monitoring, control and mitigation of risks in a company. The premise of corporate risk management is that organizations exist to generate value to stakeholders but they face uncertainties. And the challenge for managers is to determine the extent to which they accept these uncertainties. By means of corporate risk management, managers can effectively deal with uncertainties, risks and opportunities (COSO, 2007).

Although people often attribute negative connotations to risks by associating them with events with negative effects such as losses resulting from factors that may be internal and external to the organization, good risk management can have positive effects. Its main effects are felt internally with a better organizational functioning due to an adequate management of corporate resources and prevention of inappropriate behaviors (Tavares, Pacheco and Pires, 2016).

When it comes to integration of public policies with other sectors of the economy, Fabre and Eyerkaufer (2018) state that risk management is an instrument that, in an interinstitutional way, can eliminate or reduce risk factors, manage adverse events when they occur in vulnerable scenarios and still recover such scenarios. They also state that risk management undergoes a paradigm shift in Brazil, where the culture of reaction gives way to the culture of prevention.

Prevention, for Melo, Castro e Regis (2008), constitutes a set of actions with the purpose of avoiding errors or defects, including the organization of work and social relations in the company. Therefore, true prevention is part of the work and involves three crucial actions: planning operations in advance, developing correct procedures and preparing professional training programs. Finally, the authors state that, according to research carried out in this area, analyses of accidents and diseases occurring at work point out, as the main cause, deficiency in management of integration of risk prevention, aligned with productive processes. Para Piza (2000), prevention is synonymous with profit and means ensuring that the productive process shall be carried out in harmony.

Bonfante *et al.* (2017) have developed a simplified occupational risk management model that is easy to be implemented and adopted by companies based on accidents that may occur because of not following work-related security legislation. For this, a qualitative research was carried out in 15 industrial companies that identified deficiencies in work risks management. The model basically consists of developing a strategic plan aligned with the company's various sectors, such as production and security, in which everyone feels valued from the process of monitoring occupational risks, from identification to handling risks. In this way, the aim is to reduce risks and, consequently, costs of possible work accidents.

2.1 Costs in work accident risk management

According to Silva and Mendonça (2012), in a context of a globalized world it is important that organizations be not concerned only with the development of production and commercialization of their products or services. It is important that companies see their employees not only as mere productive resources but be concerned about impacts of activities on workers' health and security as well as the consumer market and society as a whole. According to Franz (2006), costs are significant for society but difficult to measure. Benite (2004) reinforces that, in addition to financial costs, it is necessary to emphasize and take into account consequences caused in families such as suffering and loss of quality of life.

The nomenclature used in managerial accounting research may cause divergences of understanding even in accounting science itself. In international research, the term "cost" is already consolidated as synonymous with general expenses. However, some authors in Brazil such as Martins (2010) define expenditure as the sum of companies' cost, expenses and investments. In this study, the international concept of costs and the national language of expenditure shall be used as synonyms, both to represent resources that companies use in the process of managing risks of work accidents.

Franz (2006) states that the cost of prevention is related to costs of quality because, when seeking quality, prevention is obtained and vice versa. Costs of accidents may be related to the lack of quality in the workplace.

Costs of prevention or security, as named by Franz (2006), are related to time and resources used in accident prevention planning and controls implemented in workplaces, since it is possible to prevent most work accidents. Lima (2003) has demonstrated by a cost analysis carried out at the company *Japan Industrial Safety and Association* that security investments are

paid by the reduction of accidents and by the following returns: a) better efficiency and productivity; b) greater motivation for workers; c) lower absenteeism; d) lower turnover of workers; e) better quality of work; f) lower medical expenses.

Costs of work accidents or from non-security are related to accidents occurring, economic losses and expenses caused, such as medical costs, machine losses, lost time, lost motivation, productivity decrease, among others (Franz, 2006). However, Benite (2004) points out that knowing the costs of non-security and security is not a simple task, since variables involved are diffuse and difficult to size such as, for example: How much does an employee's death cost? How much does an accident hurt a company's sales? What is the percentage of productivity decrease resulting from reduction of motivation of teams that have witnessed an accident?

Cost of non-security, as mentioned by Franz (2006), must be disclosed to company officers. For Benite (2004), the volume of wasted resources every time an accident occurs already serves as a strong argument for encouraging investment in security. Costs of non-security, according to Benite, are linked to handling consequences while the cost of security is associated with the time and resources used to plan prevention.

In addition to the concepts of "prevention costs" (or "security costs") and "accident costs" (or "non-security costs") presented by Benite (2004), Franz (2006), Vianna and Santos (1976) as well as Lopes *et al*. (2010) also present the concept of "insured cost" and "uninsured cost." As for authors Liu *et al*. (2009), they adopt the terms "insured" and "uninsured" to refer to direct and indirect costs.

According to Vianna and Santos (1976), insured costs correspond to Work Accident Insurance (SAT, in the Brazilian Portuguese abbreviation) paid by employers to INSS (Brazilian social security authority), the collection of which is calculated as follows:1% (one percent) for companies whose activities present work accident risks considered to be mild, 2% (two percent) if work accident risks are considered medium and 3% (three percent) if work accident risks are considered serious.

Vianna and Santos (1976) complement by arguing that the percentage is calculated on the payroll and collected with other contributions due to INSS. Uninsured costs, in turn, according to Brazilian Association of Technical Standards (ABNT, in the Portuguese abbreviation) (2001), correspond to the total expenses not covered by SAT and difficult to compute such as those resulting from work interruption, employees' leave of absence, equipment damage, normal work disturbance and uninsured assistance activities.

Due to the several concepts dealing with the same variables and considering that there is a divergence in some cost classifications, Table 1 presents a summary of the main costs addressed in the literature, classifying as direct costs those listed before the occurrence of an accident and indirect costs those incurred after an accident.

Table 1
Costs discussed in the literature

Direct Costs	Authors	Indirect Costs	Authors
1. Keeping work security teams	Benite (2004)	1. Legal expenses	ABNT (2001)
2. Time to develop collective protection projects and facilities		2. Recruitment time and costs for training new employees	ABNT (2001); Franz (2006)
3. Workers' time used during training activities		3. Cost of medical care, drugs and rehabilitation to work	Franz (2006)
4. Infrastructure maintenance	Benite (2004); Franz (2006)	4. Payments of 15 days of leave of absence and indemnities	
5. Costs with medical exams/PCMSO		5. Losses and costs of damage to machinery and equipment	ABNT (2001); Franz (2006); Lopes *et al*. (2010);
6. Purchase of PPE		6. Loss of working time of the injured and coworkers	
7. Identification and orientation plates for workers		7. Loss of motivation and drop in productivity	
8. PPRA program	Franz (2006)	8. Increased costs to employers in relation to Brazilian social security and other institutions that provide benefits to workers	ABNT (2001); Lopes *et al*. (2010);
9. Cost related to SAT insurance	Lopes *et al*. (2010);	9. Additional costs due to production interruption generated by difficulty to perform activities before deadlines, penalties for delay, loss of bonuses for meeting deadline, payment of overtime, among others	
		10. Costs of subsequent accidents as a result of agitation or moral weakness – emotional state – of other employees due to the occurrence of an initial accident	
		11. Costs to employers of full payment of salary to the injured on their return to work, even if the job performed by that employee – who is not yet fully recovered – has for some time some value that is lower than its normal one	Lopes *et al*. (2010);
		12. Indirect costs per accident victim, such as lighting, rent and other items that continue for the company, even while the injured is still absent and is not producing	

Source: prepared by the authors (2018).

Ramos, Arezes and Afonso (2014) also specify that for employers there are costs of payments in absence of employees, insurance premiums, loss of production costs, administrative and legal costs. For employees, costs are lost wages, compensation costs, health care, rehabilitation, among others. Finally, costs to society are those not borne by employers or employees and include tax relief, benefit payments, rehabilitation as medical treatment, related administrative and legal activities.

According to Lopes *et al*. (2010), companies are dynamic organizations in which sectors or departments act/interact in a strategic way, seeking to achieve specific objectives such as profit, growth and permanence in the market. According to Santana *et al*. (2006), in countries that advance in the field of prevention, work accident costs are seldom accounted for. They further claim that accidents account for 4% to 10% of gross domestic product (GDP), with higher rates in developing countries.

While some costs are easily perceived, others are not fully identified, making it difficult to measure them (Lopes *et al*. 2010). Thus, they also state that risk minimization programs seek to reduce the occurrence and severity of occupational accidents while at the same time contributing to reduce companies' costs since the incidence of accidents involves several losses for companies and workers.

Brazil in 2015 spent 10 billion BRL on severance pay and treatment for work-related injuries. Among contributing factors, the authors highlight the high work turnover, the existence of inadequate and obsolete machines and excessive working hours. They also say that due to restrictions, budget cuts and poor conditions of agencies such as the Brazilian Ministry of Labor and Employment and the Brazilian Labor Public Prosecutor's Office, there is a decrease in the enforcement of protection standards.

Pastore (2011) states that in 2009 the Brazilian social security spent 14 billion BRL with special and work-related accident benefits and that companies incur another 41 billion BRL, totaling 55 billion BRL. However, the author considers raising this ratio to 1:6 and reach a total expenditure of business and government of 71 billion BRL, which represented 9% of the country's total payroll, which is a significant number. In addition to that, Pastore (2011) claims this is an underestimated cost, since it takes into account only the so-called on-the-book workers. According to the author, SUS (Brazilian Portuguese abbreviation for Brazilian government Unified Health System) serves many accident victims and sick people from the so-called off-the-book workers group whose expenses are paid by another agency, the Brazilian Ministry of Health and not by the Brazilian social security.

Employers do not fully compensate their employees for work-related health costs. Part of the medical expenses and lost wages are covered by insurance companies and social insurance systems. However, costs related to loss of quality of life are borne by workers and their families and need to be taken into account (Ramos *et al*., 2014).

According to Ramos *et al*. (2014), it is incumbent on the State and society to cover the costs of hospitalization, treatment, recovery, payment of social benefits to the injured, as well as costs associated with reintegration of these employees into the labor market. We must also take into account implications on productivity and competitiveness in the economy. The authors have sought to answer the following questions: How much to invest in health and security at work? How much to spend on preventive measures? When does every investment need to be made?

2.2 Risk and disaster management processes adopted in Brazil

In the literature, some methodologies have emerged to manage risks such as COSO (2007), MBOK (2004) – focused on project risk management – or ISO 31000 – Risk Management. In companies' day to day, instruments to aid in risk control have also appeared such as risk maps or preliminary analysis of risks (APR, in the Brazilian Portuguese abbreviation). The authors' efforts are focused on estimating and comparing costs in the companies analyzed, classifying them as "direct and indirect," "accident costs and prevention costs," "insured costs and uninsured costs." But there is no relationship between the management of risks involved and the costs generated by avoided or repaired accidents.

Thus, the study has sought support in the methodology adopted by Civil Protection and Defense in Brazil and in the world, which adopts a management process in which, according to CEPED/UFSC (2014), in Civil Defense, actions related to disasters and risks include pre-disaster phases, in particular risk management (prevention, mitigation and preparedness), during events (response) and afterwards (recovery). The last two situations refer to disaster management according to Figure 1.

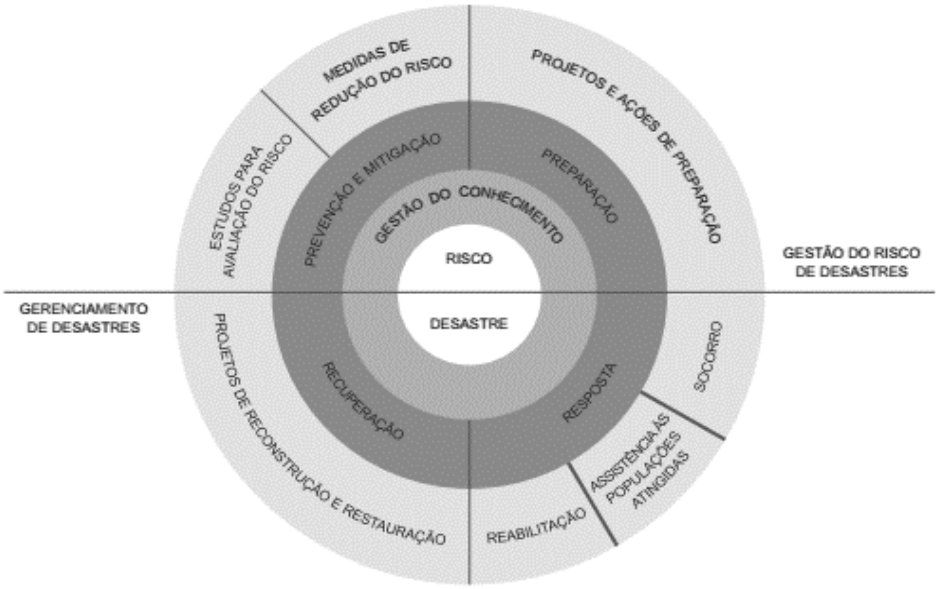

Figure 1. Civil Protection and Defense management cycle
Source: adapted from Ferreira *et al*. (2012, p. 52).

For CEPED/UFSC (2014), prevention represents the set of measures adopted in advance to avoid the installation of risk situations and, if they are installed, that they become disasters. As for mitigation, it is the set of measures aimed at reducing or limiting the establishment of risk situations. Mitigating measures seek to reduce the consequences of an event, if it materializes.

Eyerkaufer (2017) states that mitigation should be the target of strategies in management of risks and disasters, since it acts to minimize harmful effects generated by adverse events that often can not be prevented. Preparation concerns inter-agency efforts to predict, respond to and recover from impacts from adverse events or likely, imminent or current conditions related to threats (United Nations International Strategy for Disaster Reduction [UNISRD], 2009).

The Office of U. S. Foreign Disaster Assistance [OFDA] (2011) corroborates that responses correspond to actions performed in view of adverse events in order to save lives and reduce suffering and losses. Finally, recovery is the process of reestablishing normal living conditions in the affected community, starting immediately after the end of the emergency phase or disaster management. It contains two areas: rehabilitation and reconstruction (Lapolli, 2013).

Presenting a discussion for work accident risk management, object of this study, Bergamini (1997) emphasizes that improving security, health and work environment increases productivity and minimizes final product costs as it reduces process interruptions, absenteeism and accidents and/or occupational diseases.

The literature related to work risk management does not distinguish the phases of before, during and after accidents. Therefore, similar models of processes have been searched to include such segmentation, since the effort and type of actions are different in the different phases of processes.

2.3 Previous studies

Piza (2000) and other authors such as Benite (2004) and Melo *et al*. (2008) point out that prevention is always the best way to deal with work accident risks. Another fact observed, and already contextualized, concerns the composition of costs to estimate their measurement and impacts. There is no single understanding in the literature for naming/classifying costs or how this composition takes place.

For Benite (2004), costs incurred with accidents, more specifically non-security costs, are due to inadequately handling health and security at work (SST, in the Brazilian Portuguese

abbreviation). The author has analyzed the implementation of a security management system for construction companies by means of a case study in a construction company, since it is one of the sectors that presented the most accidents at the time. Results have shown that there was a belief in the company that accidents were caused by workers, not because the environment was inadequate. It has also been realized that construction companies acted in a reactive way in relation to what is recommended in the legislation. Thus it has been concluded that, rather than implementing a management system, it was necessary to create a culture of prevention in the company.

Along these lines, Franz (2006) has sought to compare accident costs and costs incurred to prevent possible accidents by analyzing a construction company in the Brazilian city of Florianópolis. Results have shown higher costs in relation to investments to prevent possible accidents than in relation to those that actually occurred. But the author states that investment in prevention brings return to the company insofar as it "reduces workers' leave of absence and gives employees the feeling that entrepreneurs care about their lives" (Franz, 2006, p. 45). She further states that without security costs (investments, in this case), risks of accidents would be greater, even because of possible stress and unmotivation. And amounts to repair such accidents would be high, such as costs that would come from labor proceedings filed against companies. She concludes that investing in security brings returns over time.

Lopes *et al*. (2010) have studied similar costs but instead of security and non-security costs they used the terms insured and uninsured. Insured costs are related to employees' payroll, social security factors etc. And uninsured costs would be others related to accidents. The authors have sought to analyze and understand the relationship between these costs from the analysis of accidents occurred in 2007 in two automotive parts companies of the Brazilian state of São Paulo. The survey has pointed out companies' lack of concern for taking into account and accounting for uninsured costs, which in the case referred mainly to those related to labor. Relationships found indicate less concern about accidents since the salary paid to employees is also lower. In this sector, low-cost labor is employed. Therefore, low cost is uninsured, despite the high severity of accidents. In summary, the authors say that more lives are at risk and there is less investment in qualification and preparation.

Bonfante *et al*. (2017) have conducted a study on work accident risk management in the largest industrial companies in a small municipality in the Brazilian state of Santa Catarina. Results from the study have shown flaws in legislation compliance, companies' policies towards the subject and, consequently, a significant number of accidents. Although not being its purpose, it has been noted in this study that some entrepreneurs have complained about the cost-benefit situation of undertaking work accident risk management.

Due to the lack of greater congruence among the terms presented in the topic of costs and studies that integrate cost management and risk management – and still trying to understand how it costs the most – the study has sought a model that would fit the objective then proposed, the model presented by the Civil Protection and Defense (Figure 1). Also due to the various terms adopted, such as "cost," "expense" and "disbursement," in this study the nomenclature "costs" shall be adopted to discriminate amounts spent with SST.

3 3 METHODOLOGY

Given the importance of allowing managers to simulate costs in the various phases of the work accident risk management process, this study proposes a simulation tool for the costs of the process of prevention, mitigation, preparation, response and recovery in work risk management. This is a descriptive research with a qualitative approach, carried out as a case study, the results of which can be generalized by means of adequacy of the instrument generated.

It is suggested that initially a new structure and cost classification be recognized. The literature proposes to classify as direct costs versus indirect costs, insured costs versus uninsured costs or prevention costs versus accident costs. Considering the different moments in which costs can and should be incurred, in order to avoid accidents or minimize their effects or to prepare teams for response and recovery at the time of accidents, a new and wider classification is proposed for a work accident risk management process. Figure 2 represents the new classification proposed by this research, considering that costs may occur in three different moments in relation to the accident: before, during and afterwards.

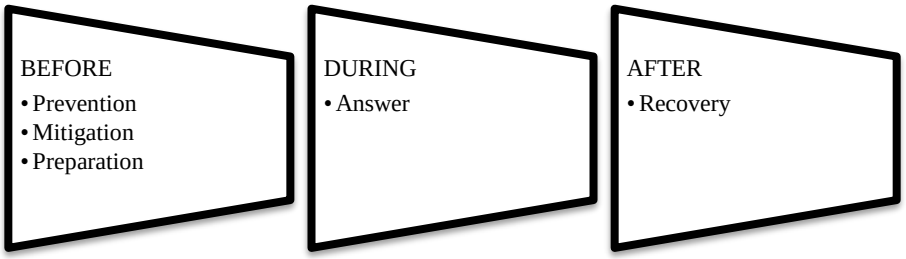

Figure 2. Classification of costs for work accident risk management
Source: prepared by the authors (2018).

A simulation tool has been developed to compare the current cost classification in work accident risk management with the proposed new structure, the cost elements of which have been obtained from several unified studies.

Once the simulation tool has been developed, its validation was sought by means of an interview with the owner of a construction company. The case study allowed the collection of data related to work accident risk management in 2016, as well as accident costs in the same company. Data collection took place in April 2017 by means of two semi-structured interviews and analysis of document such as PPRA, PCMSO and CATs.

The owner of the company, intentionally chosen, was interviewed. The interview followed the script of elements listed in the simulation instrument, which shall be discussed in the next section. From the cost elements presented by ABNT (2001), Benite (2004), Franz (2006) and Lopes *et al*. (2010), we have sought to unify in a convergent pattern, even complying to its classification, separated by direct and indirect costs, according to Table 2.

Table 2
Elements of direct and indirect costs in the work accident risk management

Abbreviation	Direct Costs
Da	Keeping work security teams
Db	Time to develop collective protection projects and facilities
Dc	Workers' time used during training activities
Dd	Infrastructure maintenance
De	Costs with medical exams/PCMSO
Df	Acquisition of EPIs
Dg	Identification and orientation plates for workers
Dh	PPRA program
Di	Cost related to SAT insurance
Abbreviation	**Indirect Costs**
Ia	Legal expenses
Ib	Recruitment time and costs for training new employees
Ic	Cost of medical care, drugs and rehabilitation to work
Id	Payments of 15 days of leave of absence and possible indemnities
Ie	Losses and costs of damage to machinery and equipment
If	Loss of working time of the injured and co-workers
Ig	Loss of motivation and drop in productivity
Ih	Possible increased costs to employers in relation to Brazilian social security and other institutions that provide benefits to workers
Ii	Additional cost due to production interruption, caused by difficulty in completing the activities in the required time, fines for delay, loss of bonuses for meeting deadlines, overtime pay, among others
Ij	Costs of subsequent accidents as a result of agitation or moral weakness – emotional state – of other employees due to the occurrence of an initial accident
Ik	Costs to employers of full payment of salary to the injured on their return to work, even if the job performed by that employee – who is not yet fully recovered – has for some time some value that is lower than its normal one
Il	Indirect costs per accident victim, such as lighting, rent and other items that continue for the company, even while the injured is still absent and is not producing

Source: prepared by the authors (2018).

From the elements in Table 2, the Microsoft Excel® software spreadsheet instrument was developed, which can be visualized in the following section, where its validation takes place in a real case.

4 INSTRUMENT VALIDATION

The case study presented in the empirical research is presented in this section. It is a company that works in the civil construction field in Alto Vale do Itajaí, in the Brazilian state of Santa Catarina. In order to safeguard confidential information about the company studied, the pseudonym "Company ABC" is used.

Company ABC, which had, on average, 86 employees registered in 2016, performs different construction works, such as sheds, sidewalks, street pavements, among others, and complies with the work security legislation.

In an interview, the owner revealed the costs resulting from work accident risk management, as well as those of the accidents themselves. The cost elements were defined based on previous studies, as mentioned in the methodology section, and are listed in Table 2. For validation of the instrument, costs related to the work accident risk management at Company ABC, direct or indirect, have been identified. Data are shown in Table 3.

Table 3
Costs with work accident risk management at Company ABC, 2016

Element of cost	Annual Costs in BRL	Classification proposed in the model				
		Before			During	After
		Prevention	Mitigation	Preparation	Answer	Recovery
Da	1,880.00	376.00	376.00	376.00	376.00	376.00
Db	3,880.00	1,940.00	1,940.00			
Dc	1,500.00	750.00	750.00	750.00		
Dd	2,500.00	2,500.00				
De	4,500.00	4,500.00				
Df	3,120.00	2,496.00	624.00			
Dg	1,240.00	1,240.00				
Dh	3,850.00	1,283.33	1,283.33	1,283.33		
Di	41,000.00	41,000.00				
Direct subtotal	**63,470.00**	**56,085.33**	**4,973.33**	**2,409.33**	**376.00**	**376.00**
Ia	-					
Ib	4,300.00					4,300.00
Ic	1,125.00				787.50	337.50
Id	11,250.00					11,250.00
Ie	17,000.00					17,000.00
If	6,100.00				6,100.00	
Ig	8,000.00					8,000.00
Ih	-					-
Ii	4,800.00					4,800.00
Ij	-					-
Ik	4,200.00					4,200.00
Il	-					-
Indirect subtotal	**56,775.00**	**-**	**-**	**-**	**6,887.50**	**49,887.50**
Total	**120,245.00**	**56,085.33**	**4,973.33**	**2,409.33**	**7,263.50**	**50,263.50**

Source: research data (2016).

Some indirect costs could not be determined by the company. However, according to the owner, they are not significant. By the traditional classification of costs in direct and indirect, it is noticed that the company spends more on accident prevention than on costs generated by the accidents themselves. Ferreira *et al*. (2012) state that workplace accidents generate costs and therefore the best way to minimize them in companies is still on investing in prevention, which is the occupational security professionals' goal.

The aim was to classify direct and indirect costs in prevention, mitigation, preparation, response and recovery costs, the process of which is widely discussed in risk and disaster management. Once again, the data show that the company practically balanced its costs, considering the moments before (prevention, mitigation and preparation) and after the occurrence of the accident (response and recovery). Although it may mean balance, it is important to point out that investments made before accidents prevent life and property, while work security generates an environment conducive to greater productivity.

Figure 3 shows the cost meter of the entire work accident risk management operation.

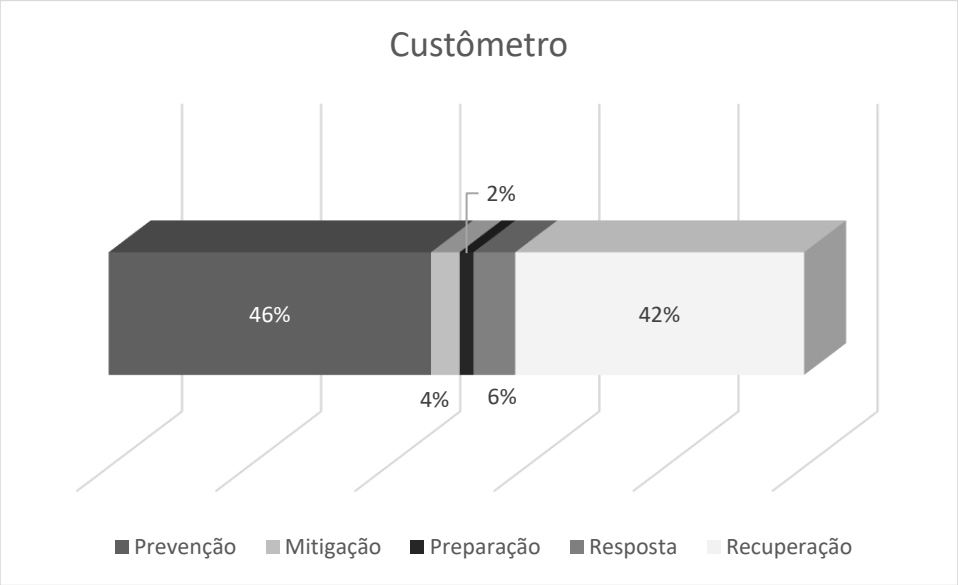

Figure 3. Cost meter
Note. It represents the percentage of each cost classification in relation to the total cost of managing work accident risks at Company ABC.
Source: research data (2016).

By the case study it was verified that the major accidents involved collision of the company's own vehicles (only material damages). In addition, an unusual accident occurred in which an employee (on the ground) threw a work tool at another employee (in the construction work roof), at which time this one jumps from the construction work to persecute the aggressor, suffering an exposed fracture in the right leg. The work was paralyzed on the day (from 2:30 pm) and the employee's full recovery took six months. A third major accident involved an electric saw (cutting disk) that resulted in an employee's left hand finger amputation and he was removed from activities for 120 days, partially compromising activities on return to work.

According to the owner, 2016 was a turning point for the company as they began to reap results from investing in accident prevention. In that period there was a decrease in accidents and, consequently, in costs in relation to previous years.

In relation to the instrument presented, it is noted that the expected cost classification allows better visualization of investments in each phase of the work accident risk management process. This is because managers shall be able to visualize costs that effectively address accidents prevention and, when not preventable, minimizing effects by means of mitigation costs, in addition to preparing the team so that response and recovery can be optimized when accidents occur.

5 CONCLUSIONS

This research has fulfilled the goal of developing a cost simulation tool for work accident risk management. Cost elements were defined based on previous research and the management methodology was adapted. Implementation in a real case brought the necessary validation to give robustness to the instrument, which can be generalized.

In spite of efforts by regulators and companies, in the Brazilian scenario, accidents continue at alarming rates, generating costs for companies and for the economy as a whole, as well as pain and physical suffering of those involved. In the literature, prevention is always pointed out as the best way but it has been noticed in this research that managers are not always aware of the importance of planning work risks. Moreover, when they do, they are not sure about how to do it effectively, that is, on what and how much to allocate in resources to establish a prevention plan.

The various studies carried out usually focus on dividing costs into direct or indirect ones, security and non-security, prevention and accident, not finding standardization in the nomenclature. In this sense, the proposed objective allows managers to measure costs at each stage of the work accident risk management process, bringing a broader view of the management process.

According to the unpublished model presented in this research, work accident risk management costs in the most diverse companies can be measured, since this allows generalization. Distribution of cost elements can be adapted to companies' branch of activity but the proposal is to classify them in before (prevention, mitigation and preparation), during (response) and after (recovery) work accidents.

In this way, it is imperative to highlight the importance of the simulation tool so that risk managers know their related costs and from these develop strategies that can protect lives and assets of those who make up the organizations, suggesting future research in this area. With expansion of research using this new model, in the future it may be possible to compare results from companies with similar characteristics.

REFERENCES

Araújo, R. P., Santos, N., & Mafra, W. J. (2006). Gestão da saúde e segurança do trabalho. *Anais do Simpósio de Excelência em Gestão e Tecnologia,* Rio de Janeiro, RJ, Brasil, 3.

Associação Brasileira de Normas Técnicas. (2001). *Cadastro de acidente do trabalho: procedimento e classificação.* NBR 14280/2001. Rio de Janeiro: ABNT.

Benite, A. G. (2004). *Sistema de gestão da segurança e saúde no trabalho para empresas construtoras.* 236 f. Dissertação de Mestrado em Engenharia, Universidade de São Paulo, SP, Brasil.

Bergamini, C. W. (1997). *Motivação nas organizações.* São Paulo: Atlas.

Bonfante, E. A., Eyerkauser, M. L., & Dallabona, L. F. (2017). Gestão dos riscos de conformidade em segurança do trabalho. *Anais do Congresso Brasileiro de Redução de Riscos e Desastres.* Rio de Janeiro, RJ, Brasil, 2.

Centro Universitário de Estudos e Pesquisas Sobre Desastres da Universidade Federal de Santa Catarina. (2014). *Gestão de recursos federais de Defesa Civil* (2a ed.). Florianópolis: CEPED/UFSC.

Ching, H. I. (2011). Contribuição das boas práticas do mercado para a eficiência na gestão do risco corporativo. *Revista Brasileira de Estratégia*, *4*(3), 257-273.

Committee of Sponsoring Organizations of the Treadway Commission. (2007). *Gerenciamento de riscos corporativos– estrutura integrada***.**1-141. Recuperado em 18 dezembro, 2018, de: http://www.coso.org/documents/COSO_ERM_ExecutiveSummary_Portuguese.pdf

Dalvesco, D. G., Fernandes, F. C., & Roncon, A. (2014). Controles de gestão atrelados ao gerenciamento de risco: uma análise das produções científicas brasileiras sob a perspectiva de redes sociais. *Revista hispana para el análisis de redes sociales***,** *25*(2), 163-185.

Eyerkaufer, M. E. (2017). *Modelo de referência organizacional estratégico para coordenação local da gestão dos riscos e desastres.* 178 p. Tese de doutorado, Universidade Federal de Santa Catarina, Florianópolis, SC, Brasil.

Fabre, V. V. & Eyerkaufer, M. E. (2018). *Disclosure* voluntário na governança de gestão de riscos e desastres: um instrumento de pesquisa. *Revista Livre de Sustentabilidade e Empreendedorismo*, *3*(2), 149-169.

Ferreira, M. M., Souza, C. E. S., Ribeiro, C. A., Galdino, D. B., & Ricci, G. L. (2012). Avaliação sobre a prevenção de riscos na atividade de trabalho em prensas. *Iberoamerican Journal of Industrial Engeneering*, *4*(8), 48-68.

Franz, L. (2006). *Estudo comparativo dos custos de prevenção e os custos dos acidentes de trabalho na construção civil***.** 60 f. Monografia de Graduação em Ciências Contábeis, Universidade Federal de Santa Catarina, Florianópolis, SC, Brasil.

Hämäläinen, P., Saarela, K. L., & Takala, J. (2009). Global trend according to estimated number of occupation al accidents and fatal work related diseases at region and country level. *Journal of Safety Research, 40*(2), 125-139. doi: 10.1016/j.jsr.2008.12.010.

Iwamoto, H. H., Camargo, F. C., Tavares, L. C., & Miranzi, S. S. C. (2011). Acidentes de trabalho fatais e a qualidade das informações de seus registros em Uberaba, em Minas Gerais e no Brasil, 1997 a 2006. *Rev. Brasileira de Saúde Ocupacional*, *36*(124), 208-215. doi: 10.1590/S0303-79572011000200004.

Lapolli, A. V. (2013). *O plano diretor e o plano de gerenciamento de enchentes do município de Rio do Sul – SC: a construção de um território seguro?* 208f. Dissertação de Mestrado em Planejamento Territorial e Desenvolvimento Socioambiental, Universidade do Estado de Santa Catarina, Florianópolis, SC, Brasil.

Lima, F. (2003). *Os Custos dos Acidentes de Trabalho nas Empresas de Construção.* Instituto Superior Técnico, Universidade Técnica de Lisboa e CEGIST. Recuperado em 18 dezembro, 2018, de: https://fenix.tecnico.ulisboa.pt/downloadFile/1970943312291338/2003_Acidentes-de-Trabalho_WP_CEG-IST_

Liu, H., Hwang, S., & Liu, T. (2009). Economic assessment of human errors in manufacturing environment. *Safety Science***,** *47*, 170-182. doi: 10.1016/j.ssci.2008.04.006

Lopes, J, N, P., Queiroz, R. P., & Leonardi, F. (2010). A relação entre os custos segurado e custo não segurado dos acidentes de trabalho. *Anais do Encontro Nacional de Engenharia de Produção*, São Carlos, SP, Brasil, 30.

Maia, A. L. S. (2015). *Acidentes de trabalho no Brasil em 2013: comparação entre dados selecionados da Pesquisa Nacional de Saúde do IBGE (PNS) e do Anuário Estatístico da Previdência Social (AEPS) do Ministério da Previdência Social.* Recuperado em 17 dezembro, 2018, de www.fundacentro.gov.br/arquivos/projetos/estatistica/boletins/boletimfundacentro1vfinal.pdf

Martins, E. (2010). *Contabilidade de Custos.* São Paulo: Atlas.

Melo, M. B. F. V., Castro, I. S., & Regis, T. K. O**.** (2008). Segurança e saúde na atividade laboral: uma contribuição para a qualidade de vida da comunidade - relato de uma experiência. *Anais do Encontro Nacional de Engenharia de Produção,* Rio de Janeiro, RJ, Brasil, 17.

Ministério da Saúde. (2014). *Inquérito sobre Atendimentos por Violências e Acidentes em Serviços Sentinela de Urgência e Emergência do Sistema de Vigilância de Violências e Acidentes (VIVA)-Capitais, Distrito Federal e municípios selecionados.* Brasília, DF.

Office of U.S. Foreign Disaster Assistance. (2011). *Bases Administrativas para gestão de riscos – BAGER: Material de Referência*. (A. V. Lapolli & A. F. Pinheiro, Tad. e adapt). Costa Rica: USAID/OFDA/LAC.

Pastore, J. (2011). *O custo dos acidentes e doenças do trabalho no Brasil.* Recuperado em 17 dezembro, 2018, de http://www.josepastore.com.br/artigos/rt/rt_320.htm

Parente, P. H. N., Luca, M. M. M., & Vasconcelos, A. C. (2015). Teoria contingencial e intangibilidade: um estudo nas empresas listadas na BM&F Bovespa. *Revista Enfoque Contábil*, Maringá, *34*(3), 21-40. doi: 10.4025/enfoque.v34i3.29568.

Piza, F. T. (2000). *Prevenção é sinônimo de lucro.* São Paulo: *Revista CIPA.*

Portal do Brasil. (2014). *Ministério divulga análises de acidentes de trabalho.* Recuperado em 17 dezembro, 2018, de: http://www.brasil.gov.br/economia-e-emprego/2014/12/ministerio-divulga-analises-de-acidentes-de-trabalho

Project Management Body of Knowledge.(2012). *A Guide to the Project Management Body of Knowledge*, PMI.

Ramos, D. G. G., Arezes, P. M., & Afonso, P. (2014). Economic analysis of occupation al risk prevention: A case study in a textile company. In R. D. J. M. Steenbergen, P. H. A. J. M. van Gelder, S. Miraglia, A. C. W. M. Vrouwenvelde (Eds.). *Safety, Reliability and Risk Analysis: Beyond the Horizon* (Chap. 5, pp. 1473-1478). London: Taylor & Francis Group.

Revista Proteção (2016). *Anuário brasileiro de proteção 2015.* Recuperado em 17 dezembro, 2018, de http://www.protecao.com.br/materias/A5jy.

Santana, V. S., Araújo, J. B., Albuquerque, P. O., & Barbosa, A. B. (2006). Acidentes de trabalho: custos previdenciários e dias de trabalho perdidos. *Revista Saúde Pública***,** *40*(6), 1004-1012. doi: 10.1590/S0034-89102006000700007.

Silva, F. P. & Mendonça, T. M. (2012). Segurança do Trabalho: um estudo em uma empresa da construção civil na cidade de Maceió. *Anais do Simpósio de Excelência em Gestão e Tecnologia*. Maceió, AL, Brasil, 9.

Soares, J. F. S. (2012). *Incidência cumulativa anual de acidentes de trabalho não fatais, estimativas nacionais para o Brasil.* 108f. Tese de Doutorado em Saúde Pública, Universidade Federal da Bahia, Salvador, BA, Brasil.

Takala, J., Hämäläinen, P., Saarela, K.L., Yun, L.Y., Manickam, K., Jin, T.W., Heng, P. Tjong, C., Kheng, L. G., Lim, S., & Lin, G. S. (2014). Global estimates of the burden of in jury and illness at work in 2012. *Journal of Occupation al and Environmental Hygiene***,**11(5), p. 236-337. doi: 10.1080/15459624.2013.86313

Tavares, F., Pacheco, L., & Pires, M. (2016). Gestão do risco nas PME de Excelência portuguesas. *Tourism e Management Studies*, 12(2),135-144. doi: 0.18089/tms.2016.12215

United Nations International Strategy for Disaster Reduction. (2009). *Terminología sobre Reducción del Riesgo de Desastres*. Recuperado em 18 dezembro, 2018, de: www.unisdr.org/files/7817_UNISDRTermonologySpanish.pdf

Vianna, J. S. & Santos, N. T. (1976). *Manual de prevenção de acidentes***.** Rio de Janeiro: Freitas Bastos.