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PRIORITIZATION OF PREVENTIVE MEASURES BY USING THE FMEA TOOL IN RISK ANALYSIS IN CIVIL CONSTRUCTION

PRIORIZAÇÃO DE MEDIDAS DE PREVENÇÃO PELA UTILIZAÇÃO DA FERRAMENTA FMEA NA ANÁLISE DE **RISCOS NA CONSTRUÇÃO CIVIL**

PRIORIZACIÓN DE MEDIDAS DE PREVENCIÓN MEDIANTE EL USO DE LA HERRAMIENTA FMEA EN EL ANÁLISIS DE RIESGOS EN LA CONSTRUCCIÓN CIVIL

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ABSTRACT

According to Social Security statistics for 2021, the number of accidents at work in Brazil remains high, with 34,000 belonging to the construction sector this year. In this scenario, risk management has high importance in risk analysis for accident prevention. Focusing on this issue, this research was carried out in the civil construction sector between the years 2021 and 2022, with the general objective of prioritizing preventive measures related to work safety in civil construction, verified by the use of the Failure Modes and Effects Analysis (FMEA) tool. In order to obtain data, observational and photographic records were made in the work analyzed in relation to the risks to which workers are exposed. Subsequently, the risk priority analysis was carried out using the FMEA tool. Among the high-Risk Priority Numbers (RPNs) there is the non-use of personal protective equipment, a serious situation due to its high risk. Thus, it can be concluded that the FMEA method contributed to the prioritization of preventive measures related to work safety for the analyzed civil construction work.

RESUMO

De acordo com estatísticas da Previdência Social de 2021, o número de acidentes do trabalho no Brasil permanece elevado, sendo que nesse ano 34 mil pertencem ao setor da construção. Nesse cenário, o gerenciamento de riscos tem elevada importância na análise de riscos para a prevenção de acidentes. Com foco nessa questão, esta pesquisa foi realizada no setor da construção civil entre os anos de 2021 e 2022, tendo como objetivo geral priorizar medidas de prevenção relativas à segurança do trabalho, constatadas pela utilização da ferramenta Análise de Modos de Falhas e Efeitos - FMEA (Failure Mode and Effect Analysis), para uma obra de construção civil. Para a obtenção de dados, foram realizados registros observacionais e fotográficos na obra analisada em relação aos riscos aos quais estão expostos os trabalhadores. Posteriormente, foi realizada a análise da prioridade de riscos com a utilização da ferramenta FMEA, sendo que entre os elevados RPNs (Números de Prioridade de Risco) está a não utilização de equipamentos de proteção individual, situação grave por apresentar alto risco. Assim, pôde-se concluir que o método FMEA contribuiu para a priorização de medidas de prevenção relativas à segurança do trabalho para a obra de construção civil analisada.

RESUMEN

Según las estadísticas de la Seguridad Social para 2021, el número de accidentes de trabajo en Brasil sigue siendo alto, con 34.000 pertenecientes al sector de la construcción este año. En este escenario, la gestión de riesgos tiene una gran importancia en el análisis de riesgos para la prevención de accidentes. Centrándose en este tema, esta investigación se llevó a cabo en el sector de la construcción civil entre los años 2021 y 2022, con el objetivo general de priorizar las medidas preventivas relacionadas con la seguridad en el trabajo, verificado mediante el uso de la herramienta Análisis de Modos y Efectos de Falla - FMEA (Análisis Modo y Efecto de Falla), para una obra de construcción civil. Para la obtención de datos se realizaron registros observacionales y fotográficos en los trabajos analizados en relación a los riesgos a los que están expuestos los trabajadores. Posteriormente se realizó el análisis de prioridad de riesgos mediante la herramienta FMEA, y entre los RPN (Risk Priority Numbers) altos se encuentra la no utilización de equipos de protección personal, situación grave por su alto riesgo. Así, se puede concluir que el método FMEA contribuyó a la priorización de medidas preventivas relacionadas con la seguridad en el trabajo para la obra de construcción civil analizada.

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1. INTRODUCTION

Among the Brazilian economic activities, one of the most negatively highlighted in terms of the occurrence of accidents at work is civil construction (Costa, 2015). With regard to work safety, so that the company can evolve in this matter and also promote sustainable development, aligning issues related to safety, health, productivity and the environment, and thus prioritizing its workers, one of the important points to be observed is the perception of risks inherent to the work environment (Fabian & Stoco, 2020).

In this way, investment in safety programs should already be carried out in the planning of the work, but this is not always the case, as it is still seen as an extra expense (Santos, 2010). These programs, which seek to eliminate or minimize risks, when implemented from the planning stage, reduce the probability of accidents. Thus, the organization, in the planning phase, must establish and assess the risks relevant to the expected results of the Occupational Safety and Health (OSH) management system (Associação Brasileira de Normas Técnicas [ABNT], 2018b).

In this context, the Failure Modes and Effects Analysis was chosen as the focus of this work, due to its proven importance in the risk management process, facilitating the prioritization of preventive actions aimed at minimizing accidents, and thus collaborating with work safety.

Thus, this research had the following general objective: to prioritize preventive measures related to work safety, verified by the use of the FMEA, in a civil construction project.

1.1 Occupational Safety

Occupational health and safety legislation have undergone several transformations. In Brazil, there have been approval of the high number of norms on the subject, accidents, labor strikes, studies and research on the area, among other facts. From 1891, it is possible to find normative documents on health and safety at work in the country, an example of which is Decree No. 1.313 (Barsano, 2018).

Brazilian legislation also includes the 38 Regulatory Norms approved by Ordinance No. 3,214 of June 8, 1978, of the Ministry of Labor, which aim to prevent accidents at work. However, regulatory norm nº 18 is the one that stands out in the civil construction sector (Barsano & Barbosa, 2018).

The purpose of NR 18 is to establish administrative, planning and organizational guidelines, aimed at implementing control measures and preventive safety systems in the processes, conditions and work environment in the construction industry. These guidelines are for living areas (toilet facilities, locker room, place for meals and accommodation); electrical installations; stages of work (demolition, excavation, foundation and rock removal; carpentry and framing; concrete structure; metallic structures; hot work; waterproofing services; roofs and coverings); stairs, ramps and walkways; protective measures against falls from a height; machines, equipment and tools; movement and transport of materials and people (elevators); scaffolding and work platforms; safety signs; training and services in

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floating. However, NR 18 covers work with other Nrs, and among them is NR 6 on Personal Protective Equipment (PPE) (Ministério do Trabalho e Previdência [MTP], 2021b).

NR 6 defines PPE as any device or product, for individual use used by the worker, intended to protect against risks likely to threaten safety and health at work. Still according to the standard in its annex I, the list of personal protective equipment is: for head protection (helmet, hood or balaclava); eye and face protection (goggles, face shield, welding mask); hearing protection; respiratory protection (respirators); torso protection (clothing, bulletproof vest permitted for use by security guards who work with firearms, to protect the torso against risks of mechanical origin); protection of the upper limbs (gloves, protective cream, sleeve, armband, fingertip); lower limb protection (shoes, socks, leggings, pants); full body protection (overalls, full body clothing); protection against falls with difference in level (safety belt with fall arrest device, safety belt with lanyard) (MTP, 2022).

Also, according to NR 6, the company is obliged to provide employees, free of charge, with equipment appropriate to the risk, in perfect condition and functioning, and it is up to the employee to comply with the employer's determinations on proper use (MTP, 2022).

1.2 Risk Management

In modern industry, this type of management began after World War II as a result of the rapid growth of industries and the expansion of risks included (Ruppenthal, 2013). Risk management or management can be used throughout the institution, that is, in its sectors, levels, activities and functions (Ferrari, 2017). According to the ISO 31000 standard on risk management, managing risks covers the company's external and internal contexts, considering human behavior and cultural factors (ABNT, 2018a).

In the case of civil construction, this is a sector that generates many accidents at work (Camino López, Ritzel, Fontaneda, & Alcantara, 2008), since the risks change daily. For this reason, tools are needed that can contribute to the risk management process at all stages of the works (Brito, 2013).

Risk can be defined as the probability of possible harm, such as injury to people, damage to the environment or equipment, etc. (Cicco & Fantazzini, 2009). Risk classification, in accordance with Ordinance No. 25, of December 29, 1994, obeys the following groups: Physical Risks (Noise, Vibrations, Ionizing and Non-Ionizing Radiation, Cold, Heat, Abnormal Pressures and Humidity); Chemical Risks (Dust, Fumes, Mists, Mist, Gases, Vapors and Compounds or Chemical products in general); Biological Hazards (Bacteria, Viruses, Protozoa, Fungi, Parasites and Bacillus); Ergonomic Risks (Intense physical exertion, Manual lifting and carrying of weight, Requirement of inadequate posture, Rigid productivity control, Imposition of excessive rhythms, Shift and night work, Long working hours); Monotony and repetitiveness; Other situations that cause physical and/or psychological stress; Risk of Accident (Inadequate physical arrangement, Unprotected machinery and equipment, Inadequate or defective tools); Inadequate lighting; Probability of fire or explosion,

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Inadequate storage, Venomous animals; Other risk situations that may contribute to the occurrence of accidents (Barsano & Barbosa, 2018).

Among the techniques used in risk management are: Hazard Identification and Operability Studies (Hazop), Preliminary Risk Analysis (APR), Checklists, What if? (What if?), FMEA, Fault Tree Analysis (AAF), among others (Cicco & Fantazzini, 2009). However, most of these characterize risks qualitatively (Cavaignac & Forte, 2018).

This study focuses on the Failure Modes and Effects Analysis method, as it allows a quantitative analysis of risks, having as principles: the determination of failure modes of components and their effects on other components in order to categorize failures for prioritizing corrective actions (Ferrari, 2017).

1.3 FMEA

Failure Modes and Effects Analysis had its first records of use in 1949, when the American military developed a tool with the purpose of determining the result of the occurrence of failure in systems and equipment. It is a tool for identifying and preventing failures in projects and processes through their analysis and proposals for improvement actions (Mcdermott, Mikulak, & Beauregard, 2009).

There are several models of the FMEA form and the company can select or elaborate it according to its reality (Palady, 2002). In civil construction, the FMEA tool has been increasingly used for risk analysis in different environments (Uchoa, Sousa, Silva, & Cavaignac, 2019).

The FMEA suggests the classification of risks through the risk priority number index or RPN, which is the product of three independent indices: severity (S), occurrence (O) and detection (D) (Stamatis, 2003).

Severity is related to the severity of the failure mode effect, normally ranging on a scale from 1 to 10, where 1 means an unnoticed effect and 10 indicates the worst effects and consequences (Palady, 2002).

Regarding the occurrence, this is related to the frequency that the failure mode occurs, also presenting a scale from 1 to 10 in which 1 indicates something very unlikely and 10 a certain occurrence, as shown in Table 1 (Palady, 2002).

Table 1. Occurrence scale.

Occurrence rating scale	Degree
Extremely Remote, Highly Unlikely	1
Remote, Unlikely	2
Small Chance Of Occurrence	3
Small Number Of Occurrences	4
Expect An Occasional Number Of Crashes	5
Moderate Occurrence	6
Frequent Occurrence	7
High Occurrence	8
Very High Occurrence	9
Certain Occurrence	10

Source: Palady (2002)

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The detection indicates what is the chance of detecting the failure mode or the causes of this mode, and as the degree increases, the possibility of finding the failure modes decreases (Palady, 2002). This research is based on Table 2 produced by Cavaignac and Uchoa (2018), due to the contribution of the authors in risk management considering the area of work safety, by proposing a methodology for obtaining the indices (severity, occurrence and detection) of FMEA under real field conditions.

Table 2. Severity (S), occurrence (O) and detection (D) indices reference.

Severity (S)		Occurrence (O)		Detection (D)	
Table of Contents	Nature of Severity	Table of Contents	Nature of Occurrence	Table of Contents	Detection Method
1	No Real Impact	6	Impact suffered	1	Visual inspection
2	Irrelevant Trauma	5	Fall with level difference	2	Tactile test/hand test
3	Trauma Requiring First Aid	5	impact against	3	
4	Temporary Disability Without Leave	5	Excessive or inadequate effort	4	
5	Temporary Disability with Short Leave	5	Pressing or trapping	5	Application of checklist/test sequence before the task
6	Temporary Disability with Long Absence	5	fall on the same level	6	
7	Partial Permanent Disability	4	noise exposure	7	
8	Total Permanent Disability	4	Contact with harmful substance	8	Instrumental inspection/mechanical tests
9	Death of Those Involved in The Process	4	Electric shock	9	
10	Death of Not Involved in The Process	3	Friction or abrasion Contact with extreme temperature	10	Lack of effective methods

Source: Cavaignac e Uchoa (2018)

2. RESEARCH STRATEGY

2.1 Research Procedures

For this study, the following procedures were adopted: selection of a large project in the city of Curitiba; data collection through on-site observational/photographic records regarding the risks to which workers are exposed; analysis of risks belonging to the work environment and the activities of employees according to regulatory standards; use of the FMEA method, applying the severity and detection indices of Cavaignac and Uchoa (2018) and the scale of occurrence indicated by Palady (2002), in order to prioritize prevention measures.

As the occurrence rates by Cavaignac and Uchoa (2018) are based on accident data in civil construction in the State of Rio Grande do Sul and social security statistics from 2016, the scale of occurrence pointed out by Palady (2002) was chosen, frequently cited in papers.

2.2 Data Collection

For data collection, the following situations were verified: the total constructed area; execution phase of the work; number of workers at this stage; existence of a risk management program; follow-up by a work safety technician or engineer; provision of

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training regarding work safety to employees. Subsequently, photographic records were made on site in relation to the risks to which workers are exposed.

The researched company is a developer, that is, it participates in the process of buying the land up to the real estate business and was carrying out a large-scale work (fictitious name "Work A"), an 8-story building including 30 apartments, in the beginning of May 2022, in the finishing stage. In this work, the use of Personal Protective Equipment was analyzed, as it presents a high risk if the equipment is not used.

3. RESULTS

3.1 Work A

Work A is a building that will have a total constructed area of 6,000 m² and which was in the finishing stage, with a number of 6 workers from the developer and 34 outsourced workers (master builder, bricklayers, tile workers, carpenters, painters and installers frames) for the execution of this phase.

Regarding work safety, it was observed that there is a risk management program and that this is carried out by a contracted company specialized in the subject together with the developer's work safety technician. It was also noted that the work safety technician accompanies the work approximately three times a week, since he also has to work on other works of the developer, and that the workers receive guidance/supervision from the foreman on the subject when the technician is not present. It was also found that everyone working on the site received training on safety from the contracted company.

3.1.1 Nonconformity Found in The Work on The Use of Personal Protective Equipment

Figures 1 to 7 show the nonconformity observed in Work A. Figure 1 illustrates the lack of personal protective equipment (hearing protection, safety glasses and gloves) for carrying out the activity. According to Regulatory Norm No. 6 (MTP, 2022), the employer must provide workers with the appropriate PPE and it is up to the employee to comply with the employer's determinations on proper use.

Figure 1. Physical risk: lack of hearing protection. Risk of accident: lack of personal protective equipment: safety glasses and gloves.

Source: Authors (2022)

Figure 2 shows the absence of personal protective equipment (hearing and respiratory protection, safety glasses and gloves) for carrying out the activity. According to Regulatory

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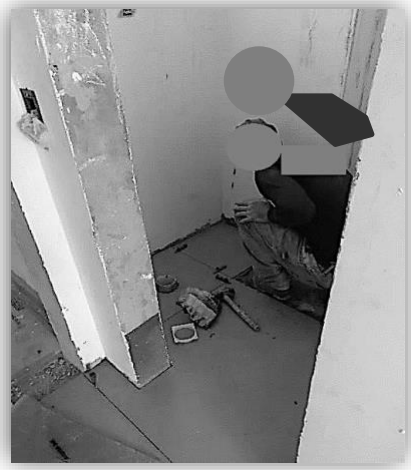
Norm No. 6 (MTP, 2022), the employer must provide workers with adequate PPE and it is up to the employee to comply with the employer's determinations on proper use.

Figure 2. Physical risk: lack of hearing protection. Risk of accident: absence of safety glasses and gloves. Chemical risk: lack of respiratory protection.

Source: Authors (2022)

Figure 3 illustrates the lack of personal protective equipment (respiratory protection, safety glasses and gloves) to carry out the activity. According to Regulatory Norm No. 6 (MTP, 2022), the employer must provide workers with the appropriate PPE and it is up to the employee to comply with the employer's determinations on proper use.

Figure 3. Risk of accident: lack of personal protective equipment (safety glasses and gloves). Chemical risk: lack of respiratory protection.



Source: Authors (2022)

Figure 4 shows the absence of personal protective equipment (helmet, safety glasses and gloves) for carrying out the activity. According to Regulatory Standard No. 6 (MTP, 2022), the employer must provide workers with the appropriate PPE and it is up to the employee to comply with the employer's determinations on proper use.

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Figure 4. Risk of accident: lack of personal protective equipment (helmet, safety glasses and gloves).

Source: Authors (2022)

Figure 5 illustrates the lack of personal protective equipment (hearing protection, helmet, safety glasses and gloves) for carrying out the activity. According to Regulatory Standard No. 6 (MTP, 2022), the employer must provide workers with adequate PPE and it is up to the employee to comply with the employer's determinations on proper use.

Figure 5. Physical risk: lack of hearing protection. Risk of accident: lack of personal protective equipment (helmet, safety glasses and gloves).

Source: Authors (2022)

Figure 6 shows the absence of personal protective equipment (helmet, respiratory protection, gloves and safety shoes) for carrying out the activity. According to Regulatory Standard No. 6 (MTP, 2022), the employer must provide workers with the appropriate PPE and it is up to the employee to comply with the employer's determinations on proper use.

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Figure 6. Accident risk: lack of personal protective equipment (helmet, gloves and safety shoes). Chemical risk: lack of respiratory protection.

Source: Authors (2022)

Figure 7 illustrates the lack of personal protective equipment (safety glasses and gloves, face shield, apron, leggings and shaving sleeve) for carrying out the activity. According to Regulatory Norm No. 6 (MTP, 2022), the employer must provide workers with the appropriate PPE and it is up to the employee to comply with the employer's determinations on proper use.

Figure 7. Accident risk: lack of personal protective equipment (safety glasses and gloves, face shield, apron, leggings and shaving hose).

Source: Authors (2022)

3.1.2 Application of the FMEA Method in Work A

Table 3 shows the application of the FMEA method in Work A:

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Table 3. Application of the FMEA method in Work A.

Figure	Fail mode	Basic cause of failure	Occurrence index	nature of occurrence	severity index	nature of severity	detection index	means of detection	RPN	Preventive measures		
										Action	Regulatory standard	NR sub-item
1	Physical risk: lack of hearing protection. Risk of accident: lack of personal protective equipment: safety glasses and gloves.	Lack of management planning (lack of monitoring by work safety professionals and other professionals with adequate knowledge in this area: workers without guidance)	9	Exposure to noise / Impact suffered	6	Temporary disability with long absence	1	Visual inspection	54	Use PPE (hearing protection, safety glasses and gloves). Use a suitable bench to provide good posture, visualization and operation conditions.	NR 6 - Personal Protective Equipment - PPE	6.5.1 It is up to the organization, regarding PPE: to provide the employee, free of charge, with PPE suitable for the risk, in perfect condition and functioning. 6.6.1 It is up to the worker, regarding the PPE: to use the one provided by the organization.
2	Physical risk: lack of hearing protection. Risk of accident: absence of safety glasses and gloves. Chemical risk: lack of respiratory protection.	Lack of management planning (lack of monitoring by work safety professionals and other professionals with adequate knowledge in this area: workers without guidance)	10	Exposure to noise / Impact suffered / Contact with harmful substance	8	total permanent disability	1	Visual inspection	80	Use PPE's (hearing and respiratory protection, safety glasses and gloves) and a suitable bench to provide good posture, visualization and operation conditions.	NR 6 - Personal Protective Equipment - PPE	6.5.1 It is up to the organization, regarding PPE: to provide the employee, free of charge, with PPE suitable for the risk, in perfect condition and functioning. 6.6.1 It is up to the worker, regarding the PPE: to use the one provided by the organization.
3	Risk of accident: lack of personal protective equipment (safety glasses and gloves). Chemical risk: lack of respiratory protection	Lack of management planning (lack of monitoring by work safety professionals and other professionals with adequate knowledge in this area: workers without guidance)	9	Impact suffered / Contact with harmful substance	4	Temporary disability without leave	1	Visual inspection	36	Use PPE suitable for the activity	NR 6 - Personal Protective Equipment - PPE	6.5.1 It is up to the organization, regarding PPE: to provide the employee, free of charge, with PPE suitable for the risk, in perfect condition and functioning. 6.6.1 It is up to the worker, regarding the PPE: to use the one provided by the organization.
4	Risk of accident: due to the position of the ladder and lack of personal protective equipment (safety helmet, goggles and gloves)	Lack of management planning (lack of monitoring by work safety professionals and other professionals with adequate knowledge in this area: workers without guidance)	9	Impact suffered / Electric shock / Fall with difference in level	9	Death of those involved in the process	1	Visual inspection	81	Use PPE suitable for the activity	NR 6 - Personal Protective Equipment - PPE	6.5.1 It is up to the organization, regarding PPE: to provide the employee, free of charge, with PPE suitable for the risk, in perfect condition and functioning. 6.6.1 It is up to the worker, regarding the PPE: to use the one provided by the organization.

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5	Physical risk: lack of hearing protection. Risk of accident: lack of personal protective equipment (helmet, safety glasses and gloves)	Lack of management planning (lack of monitoring by work safety professionals and other professionals with adequate knowledge in this area: workers without guidance)	9	Exposure to noise / Impact suffered	9	Death of those involved in the process	1	Visual inspection	81	Use PPE suitable for the activity	NR 6 - Personal Protective Equipment - PPE	6.5.1 It is up to the organization, regarding PPE: to provide the employee, free of charge, with PPE suitable for the risk, in perfect condition and functioning. 6.6.1 It is up to the worker, regarding the PPE: to use the one provided by the organization.
6	Accident risk: lack of personal protective equipment (helmet, gloves and safety shoes. Chemical risk: lack of respiratory protection	Lack of management planning (lack of monitoring by work safety professionals and other professionals with adequate knowledge in this area: workers without guidance)	9	Impact suffered / Contact with harmful substance	9	Death of those involved in the process	1	Visual inspection	81	Use PPE suitable for the activity	NR 6 - Personal Protective Equipment - PPE	6.5.1 It is up to the organization, regarding PPE: to provide the employee, free of charge, with PPE suitable for the risk, in perfect condition and functioning. 6.6.1 It is up to the worker, regarding the PPE: to use the one provided by the organization.
7	Risk of accident: lack of personal protective equipment (safety glasses and gloves, face shield, apron, leggings and shaving hose)	Lack of management planning (lack of monitoring by work safety professionals and other professionals with adequate knowledge in this area: workers without guidance)	9	Impact suffered	8	total permanent disability	1	Visual inspection	72	Use PPE (safety glasses and gloves, face shield, apron, leggings and shaving hose).	NR 6 - Personal Protective Equipment - PPE	6.5.1 It is up to the organization, regarding PPE: to provide the employee, free of charge, with PPE suitable for the risk, in perfect condition and functioning. 6.6.1 It is up to the worker, regarding the PPE: to use the one provided by the organization.

In Table 3, it can be seen that in Work A the risk of accidents predominates, with the basic cause of the failures being the lack of management planning in relation to the lack of follow-up by work safety professionals and other professionals with adequate knowledge in this area and, consequently, the presentation of workers without guidance on the subject, resulting in RPNs (Risk Priority Numbers) with a variation from 36 to 81, and recommendations specifically involving the NR 6 standard.

4. RECOMMENDATIONS OF SAFETY PROCEDURES FOR THE WORK ANALYZED

After analyzing the results of the surveyed work, it appears that the nonconformity presented in it could be improved by promoting a culture related to work safety in the company. In this context, the commitment of leaders linked to management with regard to planning and safety programs at all stages of the work is essential, which was also pointed out by Santos (2010) in his research on the use of personal protective equipment from the point of view of view of the administration and civil construction workers in Feira de Santana - Bahia; and by Cavaignac and Forte (2018), when they concluded that among the main causes of accidents at work, in a work in the municipality of Imperatriz/Maranhão, is inadequate management in occupational safety.

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Thus, these plans and programs should always include risk management, carried out by professionals with adequate levels of knowledge about work safety and with the participation of other workers, aimed at correcting unsafe conditions in the work environment and unsafe acts that reside on the human factor.

Based on the above, plans should also include investment in effective training, as pointed out by Ferreira and Nunes (2020) in their research on the application of the FMEA tool in a building in Mossoró/Rio Grande do Norte, with the objective of to raise awareness and guide the entire team (management and employees) so that they carry out clear interpretations of safety procedures and carry out their activities safely.

5. CONCLUSION

It is concluded that, in relation to the use of the FMEA tool, it contributed to the prioritization of preventive actions related to work safety for the analyzed civil construction work, through a quantitative analysis of the risks. And that when analyzing the risks according to regulatory standards and their priority using the FMEA tool, applying the severity and detection indices proposed by Cavaignac and Uchoa (2018) and the scale of occurrence indicated by Palady (2002), the non-use of personal protective equipment presented high RPNs (Risk Priority Numbers), resulting in an average RPN equal to 69, since the situation was serious due to its high risk. Thus, it can be concluded that the FMEA method contributed to the prioritization of preventive measures related to work safety for the analyzed civil construction work.

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