

PERSONAL PROTECTIVE EQUIPMENT IN RESIDENTIAL CONSTRUCTION

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ABSTRACT: Despite the construction industry playing a crucial role in boosting the economy and generating income in developing regions, the majority of operations in this sector occur informally, resulting in risks to the health and safety of workers at construction site. In light of this, the aim of this study was to identify the most commonly used Personal Protective Equipment (PPE) by workers and the primary occupational risks in four small-scale residential construction sites in the city of São José de Piranhas, Paraíba. To achieve this, observational analyses were conducted on these four residential construction sites in the city of São José de Piranhas. It was found that, despite being exposed to various occupational risks, the workers on the four sites were not using adequate Personal Protective Equipment (PPE) to protect against these risks. In this regard, informational and didactic pamphlets about the importance of using PPE were distributed to these workers with the aim of raising awareness. This study highlights the need to improve risk management and protection for these workers, especially informal laborers, to ensure the physical integrity of these workers and thus achieve a healthy and safe work environment.

KEYWORDS: Work safety. Personal Protective Equipment. Construction Industry.

INTRODUCTION

The construction sector plays a preponderant role in the Brazilian economy, making a significant contribution to the generation of both direct and indirect

employment. According to data from the Brazilian Chamber of Construction Industry (CBIC, 2020), the construction sector is responsible for generating 7.64 direct jobs and 11.4 indirect jobs for every R\$1 million invested in the industry. Furthermore, these jobs exert a notable impact on the Gross Domestic Product (GDP) of the country, resulting in a profit of R\$ 492 million and R\$ 772 million, respectively. In this context, the search for job opportunities in the construction sector is significant, particularly concerning direct employment, which encompasses activities such as building construction, the work of bricklayers, construction laborers and carpenters, among others, as defined by Pastore (1998). In addition to formal employment, the construction sector is also responsible for the creation of millions of informal jobs. According to CBIC (2022), in 2021, the sector employed a population of 7.5 million of workers, with 3.8 million of them working informally. This informality is more prevalent in the North and Northeast regions, which also record higher rates of illiteracy.

According to data from the Brazilian Institute of Geography and Statistics (IBGE), the North and Northeast regions also have the largest portion of informal activities in the construction sector. Furthermore, these regions exhibit the highest illiteracy rates, with the Northeast standing out, recording an illiteracy rate of 13.9% in 2019, equivalent to approximately 1.5 million people (IBGE EDUCA, 2020). This relationship between informal work in the construction sector and the educational level of workers is of great significance, especially considering that the majority of informal workers often lack awareness of the occupational risks they are exposed to on construction sites. The occurrence of accidents is inherent in various activities within the sector, and the absence of the use of Personal Protective Equipment (PPE) is common on construction sites employing informal workers, exacerbating the incidence of health risks and physical harm.

This issue is exacerbated in small expanding cities, where the precariousness of health and safety for informal workers stands out. An illustrative example is the city of São José de Piranhas, Paraíba, which, in 2021, had a population of 20,406 people, with construction being one of the three main economic activities, according to the Caravela website (2023). In such developing municipalities, it is crucial to analyze the occupational

risks present on small construction sites and assess adoption of protective measures by informal workers during the execution of their activities.

In the face of this scenario, this study presents an observational analysis of the main occupational risks and the use of Personal Protective Equipment (PPE) by informal workers during residential construction in São José de Piranhas, Paraíba. Additionally, worker awareness regarding the importance of Personal Protective Equipment (PPE) is encouraged through the distribution of pamphlets highlighting occupational risks and emphasizing the need to use PPE to ensure the safety, health, and physical integrity of workers during residential construction.

METHODOLOGY

The observational analysis involved inspections at four small construction sites designated for residential construction, referred to as Site 1, Site 2, Site 3, and Site 4, located in the municipality of São José de Piranhas, Paraíba. The selection of these sites considered the different phases of the construction process and the diversity in the complexity of residential projects, aiming to assess the impact of construction site complexity on the presence of occupational risks. A total of 16 workers, including informal bricklayer and construction laborers involved in the construction projects, were subject to observation, as detailed in Table 1.

Table 1: Number of workers in construction sites by job function.

Site	Number of workers per role			Total
	Bricklayer	Laborers	Others	
1	1	1	1	3
2	2	2	1	5
3	2	2	0	4
4	2	2	0	4

During the initial visits, the primary occupational hazards present on construction sites were identified, and the Personal Protective Equipment (PPE) being utilized by informal workers, the focus of the study, was documented. During subsequent visits, informative pamphlets highlighting the predominant occupational hazards on construction sites and the most common Personal Protective Equipment (PPE) among construction workers were distributed.

RESULTS AND DISCUSSION

Description of the construction sites

The construction sites referred to as " Site 1" is located along the PB 400 highway, at the outskirts of São José de Piranhas city, in the state of Paraíba. This development is intended for residential purposes and occupies the first floor of a building that also features a mechanical workshop. As depicted in Figure 1, the construction of the project was in an initial phase, characterized by the elevation of building masonry. The residence in question has an approximate area of 115.2 square meters and was being constructed by a team of three workers, consisting of a mason, a laborer, and an assistant laborer.

Figure 1: Site 1.



Site 2, illustrated in Figure 2, is situated on the first floor of a building and has a total area of 136.5 square meters, with dimensions of 6.5 meters in width by 21 meters in length. Located on Centenary Avenue, this project was in a more advanced construction stage, with the masonry of the building nearly completed. The construction was being carried out by a team consisting of two masons, two laborers, and one ironworker.

Figure 2: Site 2.



Site 3 pertains to a single-story house construction with a total area of 84 square meters, located in the Zuza Holanda neighborhood. The construction was in the finishing phase, as depicted in Figure 3, and was under the responsibility of a team comprising four workers, including two masons and two laborers.

Figure 3: Site 3.



Site 4 encompasses an area of 240 square meters, with dimensions of 6 meters in width by 20 meters in length. It is intended for residential purposes and features both ground and first floors, as demonstrated in Figure 4. In this case, the construction phase was already well advanced, with the masonry and roofing practically completed, and the finishing stage was about to begin. The construction was being carried out in the Zuza Holanda neighborhood by a team of four workers, including two masons and two laborers.

Figure 4: Site 4.



OBSERVATION OF WORKERS' EXPOSURE TO OCCUPATIONAL HAZARDS

Based on the visits conducted at the four construction sites and the observation of workers' exposure to risks in the work environments, various classes of occupational hazards were identified, including physical hazards, chemical hazards, ergonomic hazards, and accident risks. Furthermore, we considered the construction phase in which each site was at the time of the visits, as this stage influences the presence or absence of certain risks.

The results of observational analyzes on the presence of these risks are summarized in Table 2, where the "X" marking indicates the occurrence of risks in the construction sites visited. As Table 2 demonstrates, we observed that occupational risk, such as exposure to heat, excessive noise, vibration, dust containing harmful substances,

inappropriate posture, Lifting and carrying of weight, use of inadequate, defective, or damaged work instruments, operation of unprotected machinery, and lack of safety signage were present in all four analyzed construction sites.

Table 2: Occupational hazards observed on the construction sites.

OCCUPATIONAL RISK	CONSTRUCTION SITE / DESCRIPTION			
	Site 1 First floor, masonry being erected	Site 2 First floor, masonry in the final stages of completion	Site 3 Single-story and in the finishing phase	Site 4 Single-story and first floor, in the finishing phase
PHYSICAL AGENTS				
Heat	X	X	X	X
Noise	X	X	X	X
Vibration				X
CHEMICAL AGENTS				
Dust containing harmful agents	X	X	X	X
Mists containing harmful agents			X	
Vapors containing harmful agents				
ERGONOMIC RISKS				
Inappropriate posture	X	X	X	X
Lifting and carrying of weight	X	X	X	X
Prolonged work hours				
ACCIDENT RISKS				
Inadequate, defective, or damaged work instruments	X	X	X	X

OCCUPATIONAL RISK	CONSTRUCTION SITE / DESCRIPTION			
	Site 1 First floor, masonry being erected	Site 2 First floor, masonry in the final stages of completion	Site 3 Single-story and in the finishing phase	Site 4 Single-story and first floor, in the finishing phase
Operation of unprotected machinery	X	X	X	X
Lack of safety signage	X	X	X	X
Incorrect storage		X	X	X

No risks were identified associated with the presence of vapors containing harmful substances and extended working hours during visits to the four construction sites. Furthermore, in Table 2, it is observed that the occupational risk related to vibration was only noted at Site 4. This occurred during the visit when a laborer was performing manual masonry cutting using a mallet and chisel, generating vibration and noise at the construction site.

Among the occupational risks identified at the four construction sites, the chemical risk stands out due to the presence of dust containing harmful substances, primarily attributed to the abundance of cement and sand at the construction sites. It is important to emphasize that the generation of dust is common in almost all construction and civil engineering demolition activities, especially in the preparation of mortar, which often contains sand and cement in its composition. The mechanical production of mortar in concrete mixers can intensify the formation of dust, potentially leading to respiratory problems such as sinusitis, rhinitis, asthma, and other respiratory disorders among workers at the worksite.

Additionally, Table 2 reveals the presence of mists containing harmful substances at Site 3. This occurred due to the construction phase at which the site was, involving the application of paints on the walls of the residence. This activity can release micro-droplets of harmful substances, which may impact the health of the workers. In general, this risk is associated with the dispersion of toxic vapors in the work environment, especially when

the paints contain solvents in their composition or when dilution is required. The lack of appropriate respiratory protection can result in the inhalation of these toxic substances, causing harm to the health of the workers. In addition to the occupational risks listed in Table 1, other risks at the construction sites were also observed, including the risk of falls, electric shock, falling objects, and hazards from sharp and piercing objects.

PERSONAL PROTECTIVE EQUIPMENT (PPE) USED DURING TASK EXECUTION

During visits to the four construction sites, an observational analysis was conducted to verify whether informal workers were using essential Personal Protective Equipment (PPE) to ensure their safety on the construction sites. These PPEs include protective helmets, safety glasses, respirators (masks), ear protectors, gloves, boots, sleeves, and safety belts. Table 3 presents the results of observations regarding the use of these PPEs, where "X" indicates whether the workers were using these equipment during the execution of residential construction activities.

Table 3: The key Personal Protective Equipment (PPE) observed on the construction sites.

Site	Trabalhador	PPE							
		Protective helmets	Safety glasses	Respirators (masks)	Ear protectors	Gloves	Sleeves	Boots	Safety belts
1	Mason	-	-	-	-	X	X	X	-
	Laborer	-	-	-	-	X	X	X	-
	Assistant laborer	-	-	-	-	X	X	X	-
2	Mason 1	-	-	-	-	-	X	X	-
	Mason 2	-	-	-	-	-	X	X	-
	Laborer 1	-	-	-	-	-	X	X	-
	Laborer 2	-	-	-	-	-	X	X	-

	Shipowner	-	-	-	-	-	-	X	-
3	Mason 1	-	-	-	-	X	X	X	-
	Mason 2	-	-	-	-	-	X	X	-
	Laborer 1	-	-	-	-	-	X	X	-
	Laborer 2	-	-	-	-	-	X	X	-
4	Mason 1	-	-	-	-	-	-	-	-
	Mason 2	-	-	-	-	-	-	-	-
	Laborer 1	-	-	-	-	-	X	X	-
	Laborer 2	-	-	-	-	-	-	-	-

Based on the observations recorded in Table 3, it was noted that all workers at the four analyzed construction sites were not using protective helmets, safety glasses, respirators (masks), ear protectors, and safety belts for protection against falls due to differences in height. On the other hand, during the visit, it was observed that informal workers at Site 1 were using gloves and boots, as well as Mason 1 at Site 3. Additionally, at Site 2, only boot-type footwear was being worn by the workers, including masons and laborers.

When comparing the four construction sites, it was observed that Site 4 exhibited the least compliance in the use of PPEs. In this location, only Laborer 1 was using boots and sleeves for the protection of arms and forearms. This was surprising as this construction site was more complex, featuring both ground and first floors. Therefore, it was expected to be more stringent in the use of PPEs to ensure the safety of workers. However, the construction site at Site 4 was the one that exhibited the most unsafe conditions and situations. A highlighted situation in Site 4 can be observed in Figure 5, where Laborer 1 was performing a masonry chase to introduce conduits into the electrical system. During this manual task, using a chisel and a mallet, the worker was not wearing gloves and goggles to protect their hands and eyes from small masonry fragments that were dislodging, thereby increasing the risk of physical injuries.

Figure 5: Laborer 1 from Site 4.



The absence of protective helmets was common across all four analyzed construction sites, with workers opting to wear hats and caps. While these do not provide the same level of protection against head impacts as helmets, they are often chosen due to sun exposure during work activities on construction sites. In summary, the presence of occupational risks on construction sites is a reality due to the complexity of the activities performed. Therefore, it is crucial to identify these risks, implement preventive measures to control or minimize them, and, when necessary, provide workers with appropriate Personal Protective Equipment (PPE) to protect them. Protective measures, such as the use of sleeves to guard against heat, masks to prevent the inhalation of harmful agents, ear protection against loud noises, and gloves and boots to avoid direct contact with hazards, are essential in the construction industry. This is particularly crucial where harmful agents from materials like cement and lime, as well as sharp and piercing objects, are present on construction sites.

RECOMMENDATIONS FOR IMPROVING WORKER SAFETY

Norma Regulamentadora (NR) 1, which addresses general provisions and occupational risk management, stipulates that it is the employer's responsibility to communicate occupational risks present in the workplace to workers. Additionally, the employer is required to inform workers about the measures adopted to eliminate or reduce these risks. Furthermore, NR 6 emphasizes that the employer must provide, free of charge,

Personal Protective Equipment (PPE) suitable for the risks to which workers will be exposed. However, in the construction industry, informal workers often lack access to this information and do not receive the necessary PPE. This is partly due to the fact that contractors are frequently individuals who may not be aware of the importance of workplace safety.

In this context, oversight in São José de Piranhas, Paraíba, is neglected, because the city does not have a building code, and oversight is limited only to activities mentioned in the local conduct code. This means that informal workers cannot be penalized, as NR 1 stipulates that compliance with regulatory standards is mandatory only for entities with employees governed by the Consolidation of Labor Laws (CLT), whether they are public or private institutions with direct or indirect contracts. Therefore, the informal workers analyzed in this study, due to their informal employment, do not have a connection to CLT, and consequently, their rights and working conditions are not protected by the law. It is their responsibility to adopt the use of Personal Protective Equipment (PPE).

Based on the observational analysis conducted at the four construction sites, it became evident that the workers lacked awareness of the importance of using Personal Protective Equipment (PPE), whether due to personal negligence or a lack of knowledge. Therefore, it is crucial for informal workers themselves to understand the importance of using Personal Protective Equipment (PPE) during the execution of their work activities. In this regard, one of the objectives of this study was to raise awareness among informal workers by conducting a follow-up visit to the construction sites, distributing pamphlets with information about best safety practices on construction sites. The pamphlets were designed in a didactic manner, considering that some informal workers have low levels of education. They highlighted the occupational risks to which they were exposed and illustrated the most common Personal Protective Equipment (PPE) used in construction (Figure 6). During the pamphlet distribution, a brief explanation was provided about the importance of workplace safety and the content of the pamphlet.

Figure 6: Pamphlets delivered at the visited construction sites.



CONCLUSIONS

The main objective of this study was to analyze small construction sites during the building of four residences in the city of São José de Piranhas, Paraíba. Through observations, the presence of various occupational risks was identified, and it was noted that none of the workers at the sites were using essential Personal Protective Equipment (PPE) to protect against these risks, such as helmets, safety glasses, respirators, ear protectors, and safety belts. However, it was observed that some workers were using gloves, sleeves, and protective footwear, with boots being the most observed Personal Protective Equipment (PPE) on the construction sites. Among the analyzed occupational risks, it was identified that the risk of vibration was present only at Site 4 and Site 3 was the only one where there was a risk of mists containing harmful substances due to the construction phase involving painting. When comparing the risks identified with the absence of necessary Personal Protective Equipment (PPE), it was evident that the 16 informal workers were unprotected and susceptible to workplace accidents that could result in harm to their health and physical and mental well-being.

Based on these observations and with the aim of raising awareness among these informal workers, we conducted follow-up visits to the construction sites to distribute informational pamphlets illustrating occupational risks and emphasizing the importance of using Personal Protective Equipment (PPE) for worker protection. Additionally, it was

planned, in the future, to offer free lectures and training courses for informal workers in the region to enhance their knowledge about the importance of safety on informal construction sites.

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