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Estimation of accident prevention costs in construction using a statistical model

Igor Alencar Rodrigues
Universidade de Pernambuco,
Recife, Pernambuco, Brasil
iar@poli.br

Vinícius Francis Braga de Azevedo
Universidade de Pernambuco,
Recife, Pernambuco, Brasil
vinicius.francis.ba@gmail.com

Vicente Estevam da Silva Neto
Universidade de Pernambuco,
Recife, Pernambuco, Brasil
vesn@poli.br

Bianca M. Vasconcelos
Universidade de Pernambuco,
Recife, Pernambuco, Brasil
bianca.vasconcelos@upe.br

Willames de Albuquerque Soares
Universidade de Pernambuco,
Recife, Pernambuco, Brasil
was@poli.br

ABSTRACT

Estimating accident prevention costs during the planning phase is essential for occupational safety in construction, yet data on these costs are scarce. This study analyzes and estimates prevention costs in vertical residential projects using data from 17 construction budgets. Statistical analyses, including covariance, correlation, scatter plots, and linear regression, assessed the relationship between costs and the equivalent construction area. Results indicate that prevention costs account for 2.93% of total project costs, with a strong negative correlation between average cost and equivalent area. The regression model explains 74.82% of cost variance, allowing early estimates with minimal effort. Despite the limited sample, this study contributes to Brazilian literature, providing insights for budget planning and suggesting future research with larger samples and additional variables.

KEYWORKDS: Cost benefit analysis. Health and safety. Occupational safety. Safety management.

INTRODUCTION

The construction industry plays a key role in the socio-economic development of a nation, driving growth and providing essential infrastructure for society (Berglund *et al*., 2020; Ullah, 2022). From a Science, Technology, and Society (STS) perspective, this sector also embodies a intersection between technological choices, labor conditions, and social values. Occupational accidents are not merely technical failures or isolated incidents, but rather reflect how technological systems, economic priorities, and regulatory frameworks interact (Alkaissy *et al*., 2023; Busse *et al*., 2020; Jin *et al*., 2019; Liu *et al*., 2023; Sousa; Nascimento; Chacon, 2014). These accidents compromise not only the health and safety of workers but also reveal tensions between productivity, cost optimization, and the ethical commitment to human well-being (Alkaissy *et al*., 2020; Azevedo; Vasconcelos, 2024; Oswald *et al*., 2020).

Construction is considered one of the most dangerous industries in the world (Oliveira *et al*., 2023). In 2019, according to Eurostat data, construction was the industry with the third highest mortality rate and the first with the highest rate of non-fatal accidents at work between 2011 and 2017. A report released by the Occupational Safety and Health Administration (OSHA) in 2023 demonstrated that out of the 5,486 fatal workplace accidents that occurred in the USA in 2022, the construction sector accounted for 18% (OSHA, 2023). In Brazil, the number of accidents in the construction industry is alarming. Between 2015 and 2019, an average of 34,837 accidents were recorded per year, not to mention that there is still underreporting of these incidents (Bento *et al*., 2019). Such statistics indicate not only technical or managerial shortcomings but also broader socio-technical dynamics, in which regulatory frameworks, economic priorities, and organizational cultures influence how safety is valued and operationalized in the sector (Bayamova *et al*., 2023; Nascimento *et al*., 2025; Zarei; Khan; Abbassi, 2022).

The high rates of workplace accidents in the construction industry, when compared to other industries, amplify the importance of determining the costs of occupational health and safety (OHS) in the construction sector. After all, it is evident that estimating OHS costs in the planning and design phase requires significant effort on the part of contractors (Akcay *et al*., 2018). Also, if a proper calculation of the expenses for implementing safety measures is not carried out, the project may incur losses and hinder on-site safety management (Rosa Filho, 2019).

OSH costs are categorized into two groups: accident prevention costs and costs associated with the occurrence of a workplace accident (Fellows *et al*., 2009). Accident prevention costs are those expended by the contractors themselves with the aim of preventing an accident, whereas costs associated with the occurrence of accidents are classified as direct and indirect costs and occur despite prevention efforts (Hughes; Ferrett, 2012; Tang *et al*., 2004). Indirect costs related to workplace accidents are difficult to estimate, as they involve intangible factors, such as a construction company's reputation after the death of one of its employees. On the other hand, accident prevention costs are easier to estimate, as they are costs calculated based solely on design parameters and do not depend on unknown variables.

Cost estimation is a quantitative assessment of the potential costs of resources required to carry out an activity (PMI, 2021). Cost estimation is also defined as a quick evaluation conducted based on historical costs from similar projects. Usually, cost estimation is carried out using indicators, well-established figures that serve for an initial approach to cost ranges (Mattos, 2019). Cost estimation models are valuable during the planning and design phase of a project as they can estimate construction costs with a minimum amount of information available (Kim *et al*., 2004). Therefore, this study aimed to analyze and estimate the costs related to the prevention of work accidents based on previous projects in Brazil, because estimating the costs involved in the prevention of accidents still in the planning and design stage is essential to ensure the allocation of the necessary financial resources in the implementation of effective occupational safety measures during construction of the enterprise.

OCCUPATIONAL SAFETY COSTS AND THEIR CONNECTION TO SCIENCE, TECHNOLOGY, AND SOCIETY

STS investigates how scientific knowledge and technological systems impact society (Azevedo *et al*., 2024; Bribi, 2022; Fonte, 2020). Rather than treating technology as a neutral tool or science as a purely objective pursuit, STS perspectives emphasize that technical artifacts, practices, and methodologies are embedded in broader socio-political and economic contexts (Fonte, 2020; Kahlau; Schneider; Souza-Lima, 2019; Yin; Wen; Chang, 2022). In this view, construction practices are not merely technical routines but are intertwined with decisions about which interests are prioritized and how risks are managed (Cavalcante; Costa; Rocha, 2022; Paz 2025).

This study, by estimating accident prevention costs using a statistical model, contributes to a broader discussion on STS by illustrating how quantitative tools can influence and shape safety planning (Parsamehr *et al*., 2023; Sharma; Trivedi, 2022). The cost estimation model presented here is not simply a neutral predictor of future expenditures, it serves as a sociotechnical device that conceptually and operationally addresses safety in the early stages of project development. Furthermore, cost estimating practices have direct implications for technological development. As construction companies adopt more data-driven planning approaches, estimating models can encourage the integration of digital tools such as Building Information Modeling (BIM), automated budgeting systems, and predictive analytics platforms (Khaleel; Naimi, 2022; Munaro; Tavares, 2022; Srivastava, 2022; Rodrigues *et al*., 2024).

Improving safety in construction is not just a matter of engineering and regulation, but also of questioning the social organization of knowledge, work and risk. (Bandeira *et al*.,2025; Rajabi; El-Sayegh; Romdhane, 2022; Souza *et al*., 2025). The model developed in this study can therefore be seen as part of a broader set of technologies that mediate the relationship between technical design and social responsibility. In doing so, it opens up opportunities not only for more efficient planning, but also for more ethically informed and socially responsive construction practices.

PRACTICES IN ESTIMATING ACCIDENT PREVENTION COSTS IN CONSTRUCTION

The costs of workplace accidents vary according to the type of accident. While the employer bears the majority of the costs of short-term absenteeism accidents, the community bears the highest percentage of the costs of long-term absenteeism accidents and accidents resulting in total worker disability. In Australia, based on a construction sector accident database, the average cost was found to range from AUD 2,040 to AUD 6,024.52 (Allison *et al*., 2019). In Korea, Lee *et al*. (2021) developed a framework to estimate the costs related to a fatal accident in the construction industry. By analyzing costs associated with production loss, compensation costs, and administrative loss costs, a loss of USD 2,198,260 per person was estimated.

Due to the high rates of workplace accidents in the construction industry in Korea, OHS expenses in this sector are regulated by the local government through legislation (Yang *et al*., 2021). The percentage of the budget spent on safety is determined according to the type and size of the project, ensuring a minimum necessary investment for the health and safety of the workers. However, in many countries, the initiative to ensure an accurate budget for safety in construction comes from local companies and researchers.

Gürcanli, Bilir, and Sevim (2015) employed Activity-Based Costing (ABC) to estimate the accident prevention cost (APC) in residential projects in Turkey. To utilize ABC, it was necessary to define the Work Breakdown Structure (WBS) and calculate the quantity of man-hours for each activity, rendering the method precise yet labor-intensive. With a sample of 25 medium-sized residential buildings, the average APC in these constructions was 1.92%. Towards the end of the study, a faster method, logarithmic regression, was utilized to calculate the share of safety cost. In a similar study conducted by Gürcanli, Korkutan, and Müngen (2011), focusing on small-sized residential buildings with areas up to 2000 m^2, the average safety cost was 3.73%, thus it is intuitive to say that OHS costs decrease as the total constructed area increases.

In Spain, through the analysis of 173 occupational health and safety plans, Pellicer *et al*. (2014) calculated an average accident prevention cost equal to 1.54% of the total project budget, while the average total safety cost, including accident costs and insurance costs, was approximately 5% of the budget. Nevertheless, the study did not take into account the size or type of the projects. In Korea, data on accident prevention costs from 38 construction projects were collected through a questionnaire, with 28 private projects and 10 public projects. The average accident prevention cost was 1.81% and 2.33%, respectively, indicating stricter safety measures in public projects compared to the private sector (Lee *et al*., 2022).

From the literature review, various techniques for estimating accident prevention costs in the construction industry were observed, including the use of questionnaires, Activity-Based Costing, calculations based on safety plans, and mathematical models such as linear regressions or multiple regressions. Despite the numerous possibilities for estimating and ensuring a more precise budget for occupational safety, a topic as relevant as this should be further explored in the literature, particularly in Brazil, where no work on the subject was identified.

METHODOLOGY

Given the confidential nature of the information, collecting data on expenses related to occupational safety in the construction industry is a challenging task (Sousa *et al*., 2015). However, one of the authors is a partner in a company specializing in budgeting and planning construction projects in the state of Pernambuco, Brazil. From the database of this company, founded in 2020, data from all previously conducted budgets were collected. To enable a more standardized comparison, criteria were established to ensure the projects were vertical residential buildings. Thus, data from 17 projects built up to the year 2023 were obtained.

The budgets for the buildings were prepared on different dates; therefore, the accident prevention costs need to be adjusted to the inflation index, National Construction Cost Index (INCC). This indicator was established in 1950 by the Getulio Vargas Foundation (FGV) with the purpose of tracking and monitoring construction costs in Brazil's civil construction sector. Since then, this index has been calculated and released on a monthly basis by FGV, enabling the comparison of construction costs between projects budgeted in different time periods. This is achievable because the index reflects the variation in costs of materials, labor, and construction services over time.

To help understand the proportion of accident prevention costs in relation to total construction costs (Rajendran *et al*., 2017), it was initially necessary to calculate the average weight of each cost involved. This calculation was essential to assess how significant the expenses on accident prevention were compared to the aforementioned total costs and to verify whether these values had a meaningful impact on the final project costs (Gürcanli *et al*., 2015). The variabilities of costs in relation to the obtained average values were also calculated to assess the degree of uncertainty or variability in workplace accident prevention costs (Hallowell, 2010). Lastly, a boxplot was employed to present the distribution of workplace accident prevention costs more clearly, showing quartiles, outliers, medians, and potential outliers to provide a quick view of trends, patterns, discrepancies, or instances of uncommon costs (Lee *et al*., 2022).

The costs of workplace accident prevention were estimated based on the project parameter known as the equivalent area. As defined by the Brazilian Association of Technical Standards (ABNT) in NBR 12721:2006, which deals with the evaluation of unit costs for construction in real estate development, the equivalent area refers to a virtual area whose construction cost is equivalent to the cost of the corresponding real area (ABNT, 2005). This concept is applied when the calculated area cost differs from the basic unit construction cost. In residential projects, it's common to consider the private area as the basic unit cost with a coefficient of 1, while for garage areas, the assigned coefficients vary between 0.5 and 0.75. The use of equivalent area enables the comparison of construction costs across different projects, allowing for a more accurate and consistent analysis.

For the research, linear regression was utilized, playing a pivotal role in analyzing and modeling relationships between variables. Checking basic assumptions of the model, such as linearity, independence of residuals, constant variance of residuals, and absence of multicollinearity among independent variables (Montgomery *et al*., 2021), is crucial to ensure reliable results and assist in decision-making concerning workplace accident prevention costs for a project (Rajendran *et al*., 2017).

The regression line, also known as the line of best fit, is calculated in a way to minimize the difference between observed values and predicted values (Cottrell, 2003). To understand how workplace safety accident prevention costs (dependent variable, represented as 'y') are influenced by the equivalent construction area (independent variable, represented as 'x'), the calculation through the regression line was performed; however, preliminary analyses were required.

Covariance between variables was calculated to check whether they have a raw linear relationship, measuring the joint variation of variables over the data, such that a positive covariance value would indicate a direct relationship between the variables, while a negative value would indicate an inverse relationship (Kim, 2018). Next, the coefficient of linear correlation was calculated, indicating the strength and direction of the linear relationship between the variables (Kim, 2018). The correlation coefficient varies between -1 and 1, with values close to -1 indicating a strong inverse relationship, values close to 1 indicating a strong direct relationship, and values close to 0 indicating a weak or nonexistent relationship (Asuero *et al*., 2006). Furthermore, the scatter plot is a visual tool that allowed for a clear observation of the relationship between two variables. By employing the scatter plot, patterns and linear trends could be identified, along with verifying the presence of anomalies in the correlation coefficient caused by an 'Outlier' (Shao *et al*., 2017).

Furthermore, the Shapiro-Wilk hypothesis test was applied to verify that the residuals of the linear regression were normally distributed. The normality of residuals is one of the assumptions for the estimators of regression coefficients to be the best unbiased linear estimators. If the residuals are not normally distributed, the estimators of the coefficients can become less precise, affecting the interpretation of relationships between the independent and dependent variables. Moreover, when the residuals are normally distributed, it indicates that the regression errors, the difference between observed and predicted values, have a homoscedastic distribution. This means that the variability of errors is constant across the range of the independent variable, ensuring higher quality of the statistical model.

RESULTS

In this section, the results of the study on workplace accident prevention costs will be presented and analyzed. The first part explores the collected budget data, highlighting the distribution of prevention costs among different companies and projects. Next, the relationship between prevention costs and equivalent construction area is examined through statistical analysis, including correlation, regression modeling, and significance testing. Finally, residual analysis and normality tests are conducted to assess the reliability of the model.

ANALYSIS OF WORKPLACE ACCIDENT PREVENTION COSTS

Table 01 summarizes the collected information from the database, where budgets from 13 different companies were analyzed, totaling 17 projects. The workplace accident prevention costs were grouped, resulting in an average prevention cost of 2.93%, with a standard deviation of 0.75%. It can be observed from Table 01 that the workplace accident prevention cost was equal to 0.07392 INCC/m² of equivalent area. At the reference date of this study, December 2023, the INCC-DI was priced at R$1,088.31 (USD 225.32). Therefore, the prevention cost amounts to R$80.44/m² (USD 16.85/m²) of equivalent area. Additionally, it's noticeable that the obtained data are concentrated in the third quadrant, between the median (2.94%) and the third quartile (3.26%).

Table 01 - Collected budget data

Company	Work	Equivalent built area (m²)	Total Budgeted Cost (INCC)	Budgeted Prevention Cost (INCC)	Average Budgeted Prevention Cost (%)	Prevention Cost per EA (INCC/m²)
Company A	Work 01	5554,56	10997,94	346,92	3,15%	0,06246
Company B	Work 02	4434,76	10282,48	364,06	3,54%	0,08209
Company C	Work 03	6782,86	15076,23	344,12	2,28%	0,05073
Company C	Work 04	13446,17	26742,42	640,59	2,40%	0,04764
Company D	Work 05	5394,67	12062,04	388,65	3,22%	0,07204
Company D	Work 06	4220,38	10298,79	340,50	3,31%	0,08068
Company E	Work 07	6478,38	13931,15	376,09	2,70%	0,05805
Company F	Work 08	8181,99	24582,47	620,55	2,52%	0,07584
Company F	Work 09	9998,70	25555,55	766,05	3,00%	0,07661
Company G	Work 10	6001,48	14242,85	427,51	3,00%	0,07123
Company H	Work 11	9440,40	21395,49	628,59	2,94%	0,06659
Company I	Work 12	1635,03	3848,43	199,43	5,18%	0,12198
Company J	Work 13	12781,90	46177,92	897,26	1,94%	0,07020
Company K	Work 14	9743,63	28592,00	527,60	1,85%	0,05415
Company L	Work 15	7034,10	18271,37	655,94	3,59%	0,09325
Company M	Work 16	3632,79	13034,78	361,75	2,78%	0,09958
Company M	Work 17	7950,18	23838,74	584,52	2,45%	0,07352
Average				**2,93%**	**0,07392**	
Standard Deviation				**0,75%**	**0,01806**	
Coefficient of Variation				**25,48%**		

Source: Authors

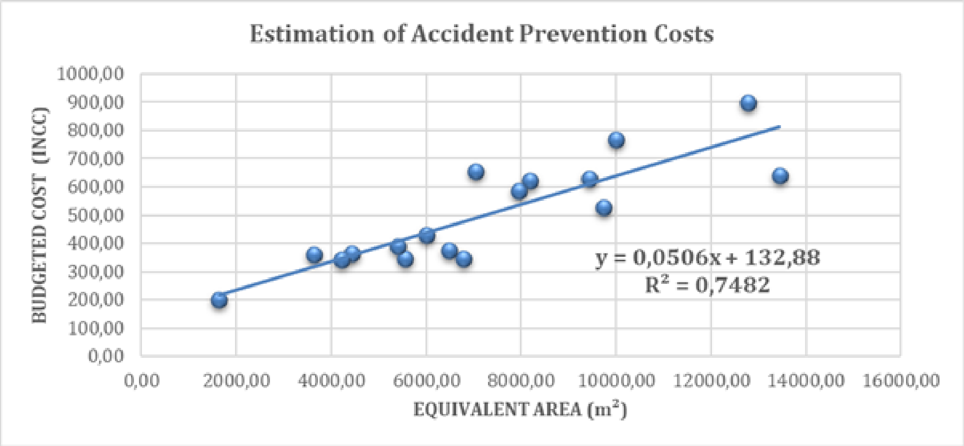
ESTIMATION OF WORKPLACE ACCIDENT PREVENTION COST

When calculating the covariance using the research data, the obtained result was cov(X, Y) = 47,477.99. This value indicates that the two variables, equivalent construction area and prevention costs, vary together in the same direction. Therefore, it can be understood that as the equivalent construction area increases, the workplace accident prevention costs also tend to increase, and when the area decreases, the costs tend to decrease.

After applying the formula for the linear correlation coefficient, the following result was obtained: r = 0.86495. This value indicated a strong positive correlation between the variables.

From the analysis of the scatter plot shown in Figure 01, a linear trend in the data can be observed. Subsequently, a linear regression was performed, and the coefficient of determination (R^2) of the regression was equal to 0.7482. This indicates that 74.82% of the dependent variable (y), workplace accident prevention costs, can be explained by the independent variable (x), equivalent construction área.

Figure 01 - Scatter plot and linear regression



Source: Authors

Analyzing the p-values in the coefficient table (Table 02), it can be observed that both have values below 0.05. Therefore, the equation, y = 0.0506x + 132.88, should remain unchanged.

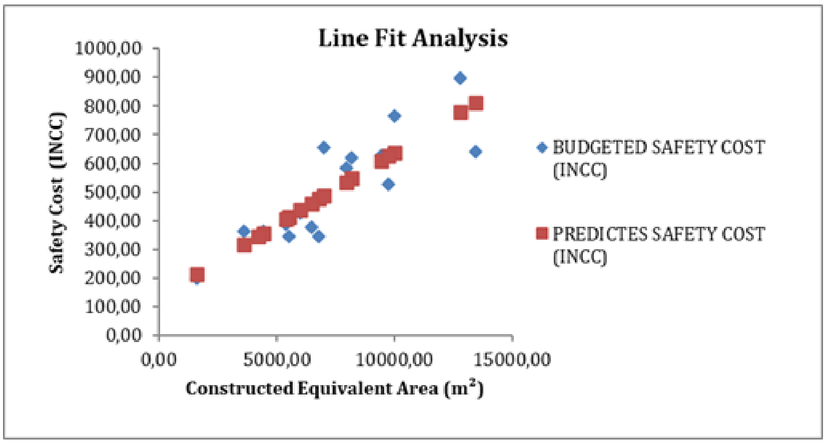
Table 02 - Coefficient table

	Intersection	Equivalent Area Built (m²)
Coefficients	132,8811	0,05062
Standard Error	59,45365	0,00758
t Stat	2,235038	6,67529
P-value	0,04105	7,41E-06
Lower 95%	6,158697	0,03445
Upper 95%	259,6036	0,06678
Lower 95.0%	6,158697	0,03445
Upper 95.0%	259,6036	0,06678

Source: Authors

From the analysis of the fitted line shown in Figure 02, some discrepancies between the prevention costs predicted by the regression and the budgeted prevention costs can be observed.

Figure 02 - Line fit analysis



Source: Authors

However, these discrepancies are small, as in Table 03, no outlier was detected through the analysis of standard residuals, as all residuals fall within the range [-2, 2].

Table 03 - Standard Residual Analysis

Observation	*Predicted Safety Cost (INCC)*	*Residuals*	*Standard Residuals*
1	414,03	-67,11	-0,72
2	357,35	6,711	0,07
3	476,20	-132,08	-1,43
4	813,47	-172,88	-1,87
5	405,94	-17,28	-0,19
6	346,50	-6,00	-0,07
7	460,79	-84,69	-0,91
8	547,02	73,53	0,79
9	638,97	127,08	1,37
10	436,65	-9,14	-0,01
11	610,72	17,88	0,19
12	215,64	-16,21	-0,18
13	779,85	117,41	1,27
14	626,06	-98,46	-1,06
15	488,92	167,02	1,80
16	316,76	44,99	0,49
17	535,29	49,23	0,53

Source: Authors

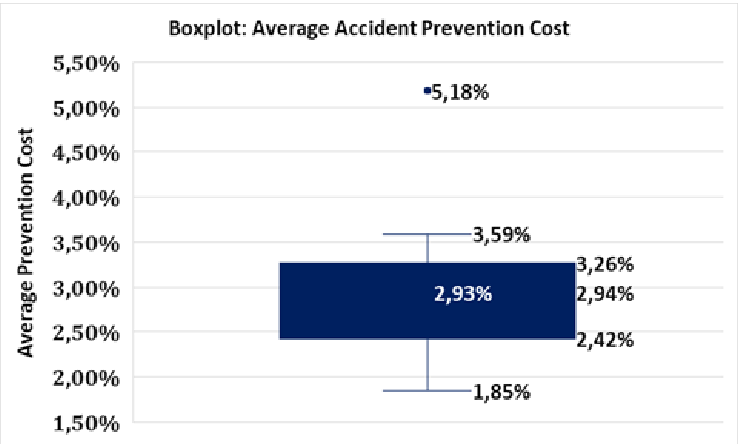
To check the normality of the residuals, the Shapiro-Wilk test was applied with a 95% confidence interval. The null hypothesis adopted was that residuals are normally distributed, and the alternative hypothesis was that the residuals are not normally distributed. The obtained p-value was 0.981, therefore, with insufficient evidence to reject the null hypothesis, it can be concluded that the residuals are normally distributed, ensuring the quality of the statistical model.

DISCUSSIONS

Although it is just a perspective, the linear regression in this study allows for safety plans to be outlined with an initial budget estimate even at the beginning of the project. Consequently, managers can allocate the necessary investment for the acquisition of personal protective equipment, collective protection equipment, health and safety training, and the hiring of area supervisors, thereby improving the odds of greater compliance and adherence to technical safety standards. This model can be understood as a tool that mediates between statistical abstraction and real-world decisions about worker protection. It does not only generate forecasts, it influences how safety is prioritized and how risks are socially managed within the construction process.

Observing Table 1, it is noticeable that the coefficient of variation (CV) of the average prevention cost was 25.48%. This variation is considered high, and part of this variation can be attributed to the detection of an outlier in the boxplot shown in Figure 03, with an average prevention cost of 5.18%. This outlier comes from Work number 12, which has the smallest equivalent area in the sample (1,635 m²), while the sample mean is 7,218.35 m², causing the costs of training and safety consulting, which don't vary much regardless of the Work size, to increase the average cost in small-sized Works. Additionally, the projects analyzed in this study are vertical constructions composed of reinforced concrete, with ceramic brick wall enclosures. In such constructions, if the buildings have similar perimeter, the number of guardrails fabricated remains relatively constant, regardless of whether the building has 6 floors or 24 floors. This is due to the common practice in the region of fabricating collective protection for 3 to 4 floors in total, which allows sufficient time for the concrete to cure and the shoring to be removed, thereby enabling the permanent construction of the ceramic brick walls.

Figure 03 - Boxplot of average workplace accident prevention cost



Source: Authors

A negative correlation of 70.97% was also observed between the average prevention cost and the equivalent construction area, indicating that as the equivalent area of the project increases, the average costs tend to decrease. As explained before, this is understandable, as the equivalent area of the project increases, some prevention costs, such as training and safety consulting costs and guardrails fabrication vary little. This reasoning is corroborated in the literature by a similar study conducted in Turkey (Gürcanli *et al.*, 2011).

Despite the differences in occupational safety regulations among the countries mentioned in the literature review, when compared with existing results on the topic, the average accident prevention cost (APC) in this study (2.93%) falls within the range found in other studies (1.54% to 3.73%). However, the APC per square meter in this study (USD 16.85/m²) was significantly higher than the costs found in other studies (USD 5.68/m²) (Gürcanli *et al.*, 2015) or (USD 8.47/m²) (Yılmaz; Kanıt, 2018). Besides the inflation difference due to the time gap between studies, with the first conducted in 2015 and the second in 2018, the pandemic has led to a significant increase in prices in the Brazilian construction industry. The inflation recorded by the INCC from the beginning of the pandemic to the present date is 41.63%. It should also be noted that the current study used the concept of equivalent area, which is always smaller than the total constructed area, thus naturally leading to a higher cost per square meter in this study.

Yet, beyond economic inflation or methodological differences, these variations also reflect broader institutional and cultural choices about how safety is valued in different national and sectoral contexts. STS scholarship emphasizes that cost structures are not merely financial, they express embedded decisions about what kinds of risks are acceptable, and which voices, workers, managers, egulators, are considered in the design and budgeting of safety (Hayes; Chester; Kingm, 2022; Oswald *et al.*, 2020)

CONCLUSIONS

The results showed that through a linear regression model, it is reasonable to have a good estimation of workplace accident prevention costs. The formula provides a very practical way to estimate this prevention cost, using only one project parameter, the equivalent construction area. This initial estimation, even during the planning and design phase, assists project stakeholders in obtaining reliable values with minimal effort expended. Such statistical models are not merely technical tools but devices that mediate how safety is quantified, prioritized, and incorporated into decision-making. Their adoption reflects broader institutional values regarding the balance between economic efficiency and worker protection.

While some countries already establish a minimum percentage of the construction budget to be allocated to health and safety at work, recognizing the importance of ensuring necessary investment to guarantee the well-being, health, and safety of workers, in other countries, the issue must be further explored and matured. This study could contribute to the literature by fostering a discussion on an important topic beyond the scope of occupational safety but fundamental to construction management as a whole, given that construction accidents entail not only a loss of time and resources for the company but also have negative impacts on society and the worker's family. Furthermore, the study provided data not found in the Brazilian literature, which is essential to support future research.

Despite the limited sample size of 17 project budgets, the objective of providing significant data and estimating workplace safety prevention costs was achieved. However, it is acknowledged that more in-depth statistical analyses can be conducted, and future studies could contribute by increasing the sample size, exploring others construction typologies, and using multiple regressions that consider other project aspects beyond the built equivalent area. A suggestion for future studies is the inclusion of the building perimeter variable, as it directly affects collective protection equipment as guardrails.

Estimativa dos custos de prevenção de acidentes em obras utilizando modelo estatístico

RESUMO

A estimativa dos custos de prevenção de acidentes durante a fase de planeamento é essencial para a segurança no trabalho na construção, mas os dados sobre estes custos são escassos. Este estudo analisa e estima custos de prevenção em projetos residenciais verticais utilizando dados de 17 orçamentos de construção. Análises estatísticas, incluindo covariância, correlação, gráficos de dispersão e regressão linear, avaliaram a relação entre custos e área de construção equivalente. Os resultados indicam que os custos de prevenção representam 2,93% dos custos totais do projeto, com uma forte correlação negativa entre o custo médio e a área equivalente. O modelo de regressão explica 74,82% da variação dos custos, permitindo estimativas antecipadas com mínimo esforço. Apesar da amostra limitada, este estudo contribui para a literatura brasileira, fornecendo insights para o planejamento orçamentário e sugerindo pesquisas futuras com amostras maiores e variáveis adicionais.

PALAVRAS-CHAVE: Análise de custo benefício. Saúde e segurança. Segurança ocupacional. Gestão de segurança.

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Correspondência: