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Statistical Analysis Of Construction Workers Conjectures About Residues And Psychosocial Perceptions

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Abstract:
Background: *The Objective Of This Work Is To Evaluate The Different Personalities And Creative Potentials Within A Psychosocial Context, Of The Workers Of The Civil Construction Industry Subsector Buildings In Order To Establish A More Precise Look To Establish Profiles And Understandings About The Generation Of Building Waste*
Materials And Methods: *The Information Collected Was Collected Through Questionnaires Carried Out With 40 Employees From Four Buildings Under Construction Located In Santa Catarina, Brazil. Analyzed By Means Of Quantitative Statistical Interpretations Of The SPSS Software.*
Results: *From The Field Research, Data Were Collected And Compared With Studies Published In Other Research Present In The Academic Literature. Interesting Considerations Were Made As The Workers' Background, Education, Life Projects, And The Learning Process Of Their Trade Were Examined, As Well As The Psychosocial Influences On Their Considerations Regarding Waste Treatment And Its Disposal.*
Conclusion: *Based On The Analyzed Data, It Was Noted That Older Workers (Above 46 Years Old) Chose To Enter The Masonry Profession Due To Limited Employment Prospects, Primarily Resulting From Their Limited Formal Education. In A Broader Sense, It Was Observed That These Workers Independently Acquired The Necessary Skills And Expertise Through Self-Determination, Indicating That Their Circumstances Compelled Them To Become Proficient In Their Respective Positions.*
Key Word*: CDR. Reuse. Solid Waste. Statistical Analysis; Professional Education.*

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I. Introduction

The construction industry is one of the most important sectors of the Brazilian industry and serves as an indicator of economic and social growth. However, it is a major contributor to environmental impacts, as it generates a significant amount of waste throughout its production chain and significantly alters the landscape. This sector... "is responsible for a considerable consumption of materials, either in terms of quantity or diversity." In comparison, "compared to the automotive industry, its material consumption, measured in mass of materials demanded, can be 100 to 200 times greater" (Souza et al., 2004; Karpinsk et al., 2009; Fernandez, 2011; Lopes and Silva, 2020; Guimarães Filho, 2016; Bristot et al., 2023).

The construction industry, in all its stages, from raw material extraction to material production, construction, use, and demolition, consumes approximately 75% of natural resources, causing significant effects. It is worth noting that many of these materials require a large amount of energy for transportation over long distances, especially in metropolitan areas where they are scarce (Jonh, 2000).

Like in all sectors, construction processes are based on a deep understanding of engineering and a strictly mechanistic perspective, often excluding the final participants, who are the workers. Their direct experiences and interactions with the process provide them with practical and real insights into problems that are often not conceived during the design and execution phases. Numerous examples in the literature and everyday accounts allow us to glimpse interesting ideas that emerge from operators and manufacturing workers, enriching both management and engineering through their practical experience and perspective.

In this context, the objective of this study is to assess the different personalities and creative potentials within a psychosocial context of workers in the Civil Construction Industry - Building Subsector (ICCSE) in order to establish a more precise understanding and profiling of Construction and Demolition Waste (CDW) generation. Statistical analyses were conducted through on-site questionnaires to determine origins, educational backgrounds, views on managers, considerations regarding fellow workers, life perspectives, personal projects, and their

creativity and application concerning the fate of CDW. Additionally, a comparative analysis was carried out using the literature available on the physical and moral situation of workers in other countries.

Ângulo et al. (2001) state that the construction sector has significant economic importance due to its broad market coverage, as it has an impact from raw materials, production, and transportation to actual building construction. Therefore, investing in this industry benefits several other sectors, as it forms a productive chain where each part gains advantages if the others are also doing well.

As the authors demonstrate, the subsector has strong growth tendencies, given that its main function is to meet the population's demand, which is constantly renewable and in constant circulation in the market. It can also be observed that this sector is easily adaptable to these new needs, as current technologies evolve in parallel with these aspirations.

II. Construction And Demolition Waste

Construction and demolition waste, according to CONAMA Resolution (2012), includes all waste generated from construction works, demolition, renovation, or even pre-construction procedures such as excavations and backfilling.

CONAMA Resolution 307 classifies construction and demolition waste into four categories. Resolution 348, issued on August 16, 2004, and Resolution 431, issued on May 24, 2011, modified the classification of Resolution 307 by including asbestos as a hazardous material (Class D) and changing the classification of gypsum from Class C to Class B, respectively. Table 1 presents the waste classification according to CONAMA Resolution 307.

Table 1: Classification of Construction Waste

CLASS	**A**	Are reusable or recyclable waste considered as aggregates: a) From construction, demolition, renovations, and repairs of pavements and other infrastructure works, including soils from earthworks. b) From construction, demolition, renovations, and repairs of buildings: ceramic components (bricks, blocks, tiles, cladding panels, etc.), mortar, and concrete. c) From the manufacturing and/or demolition process of precast concrete parts (blocks, pipes, curbs, etc.) produced on construction sites.
	B	Are the recyclable waste for other destinations, such as plastics, paper, cardboard, metals, glass, wood, and gypsum.
	C	Are the waste for which no economically viable technologies or applications have been developed to enable their recycling or recovery.
	D	Are hazardous waste originating from the construction process, such as paints, solvents, oils, and others, or those contaminated or harmful to health resulting from demolitions, renovations, and repairs of radiological clinics, industrial facilities, and others, as well as tiles and other objects and materials containing asbestos or other health-hazardous products.

Source: Own elaboration based on Resolution 307, CONAMA, 2012

According to Barros Neto (2005), demolition waste is generated in construction projects that require the complete or partial dismantling of a structure, among other similar cases. Construction waste consists of new buildings, expansions, improvements, and adjustments to existing structures.

Paschoalin Filho et al. (2002) explain that the quantities of demolition waste generated are not directly linked to the methods used in its construction. However, these factors demonstrate the quality and feasibility of recycling the materials generated, considering the chemical fusion of the various components used in the construction.

Reusable waste refers to materials that can be used without undergoing any transformation. On the other hand, recyclable waste requires processing before being reallocated. The classification of waste types is based on their origin in the construction project (CONAMA Resolution, 2012).

As demonstrated by Tessaro et al. (2012), there is a wide variety in the generation of waste, given the many root causes of the problem, including labor and applied techniques.

In the last decades, parallel to the evolution of technology for carrying out modern and sophisticated constructions, attention has been focused on the amount of waste generated in construction projects and alternatives to change this situation. According to Leite (2001), the generation of construction waste can be seen as a consequence of the entire process of modernization and urbanization that society has been undergoing, in addition to the increase in the population's financial power. All of this is associated with factors such as the lack of quality in products and services offered and natural disasters.

The main objective of waste management is to minimize the amount of waste generated and subsequently recycle or reuse what cannot be reduced, whether within the construction industry itself or in other sectors.

III. Construction workers

The Brazilian middle class has been seeking its place in the high housing deficit, and this directly reflects the resurgence of prosperity in the construction sector, which had been stagnant for years. Various government programs such as "Minha Casa, Minha Vida" and the infrastructure projects of the Growth Acceleration Program (PAC), as well as major international events such as the World Cup and the Olympics, have increased demand in the industry. However, alongside the supply, the sector faces some obstacles in its expansion, such as the availability of labor in the desired quantity and quality (Neri, 2011).

Da Silva (2020) contextualizes the existing conflict between the necessary level of qualification and the profile of the production workforce in the construction sector. The author emphasizes that among the parameters considered by companies in the subcontracting process are the characteristics of the subcontracted labor, as well as their ability to meet the requirements of quality, rationalization, and cost reduction.

Neri (2011) highlights that the construction sector is predominantly occupied by men who are heads of households and the main providers of household income. The families of these workers have improved their financial conditions in recent years. In 1996, 51.28% were in social classes D or E (i.e., with a monthly household income below R$ 1,100), the ascent began in 2003, reaching 56%, and in 2009 it dropped to 36.2%.

The author also highlights the low participation of younger individuals in the construction industry workforce. In 1996, only 34.2% of workers were between 15 and 29 years old, and this number has been decreasing each year. This reduction in youth participation in construction has exceeded the downward trend observed in the Brazilian labor market. Controlled experiments show that the proportion of young workers in construction is declining more than in other sectors. Despite aligning with new labor trends by increasing the education level of its workers and reducing early occupation and informality, the construction sector faces increasing labor shortages compared to other sectors.

IV. Materials and methods

According to John (2000), research activities rarely follow a sequential and linear logic. New discoveries require previous steps to be revisited and incorporated into the research through interactive processes. R&D studies develop new methodologies that need to be adapted to the new conditions being investigated. In terms of its design, this research is characterized as an exploratory study, as explained by Aguirre & Alonso (2011). Exploratory studies aim to develop, clarify, and modify concepts and ideas to provide testable hypotheses for further research. In terms of data sources, this study relies on secondary research, as it is based on theoretical and conceptual frameworks.

This study is qualitative in nature as it seeks to describe the complexity of a particular problem, analyze the interaction between variables, and understand and classify dynamic processes experienced by social groups (Marconi & Lakatos, 2012).

The research instrument used was a questionnaire, developed based on Vieira (2009), allowing for direct application of statistical analysis. Qualitative questions were formulated to encompass psychosocial aspects as well as their breakdown within the context of construction and demolition waste (CDW). Data were collected on-site in four under-construction buildings belonging to the three largest construction companies located in the city of Criciúma, in the southernmost region of Santa Catarina, Brazil, from May to July 2021. A total of 40 participants, including masons, foremen, and carpenters, were interviewed.

The collected data were analyzed using IBM Statistical Package for the Social Sciences (SPSS) software version 22. Quantitative variables were expressed using median and interquartile range (with Tukey's correction) when they did not follow a normal distribution, and mean and standard deviation when they did. Qualitative variables were expressed as frequencies and percentages.

Statistical tests were conducted with a significance level of $\alpha = 0.05$, corresponding to a 95% confidence level. Data distribution normality was assessed using the Shapiro-Wilk test (for $n < 50$). Mean comparisons of quantitative variables between categories of dichotomous qualitative variables were conducted using Student's t-test for independent samples when a normal distribution was observed. For comparisons between categories of polytomous qualitative variables (in cases where a normal distribution was observed), one-way analysis of variance (ANOVA) was employed.

Finally, the investigation of associations between qualitative variables was conducted using Pearson's chi-squared test, likelihood ratio test, and Fisher's exact test, followed by residual analysis when statistical significance was observed.

V. Results

The study in question presents a statistical survey of personal and professional data of construction workers. Among the questions raised, initially, data such as age, occupation, level of education, city of origin, and reasons for residing in the city of Criciúma were gathered. Table 2 below presents the general characteristics of the sample.

Table 2: Respondents' profile

Variable	Mean ± Standard Deviation or n(%) n = 40
Age (years)	43,00 ± 10,03 [1]
Age range (years)	
Up to 25	2 (5,0) [2]
26 to 35	9 (22,5)
36 to 45	8 (20,0)
46 to 55	19 (47,5)
> 56	2 (5,0)
Occupation	
Mason	22 (55,0) [2]
Mason and Carpenter	18 (45,0)
Education	
Completed elementary school	22 (55,0) [2]
Incomplete elementary school	11 (27,5)
Completed high school	4 (10,0)
Incomplete high school	2 (5,0)
Technical course	1 (2,5)
Place of origin	
Soulthern Santa Catarina	30 (75,0) [2]
North Santa Catarina	1 (2,5)
Estern Santa Catarina Westrn Santa Catarina	1 (2,5) 1 (2,5)
Other states	7 (17,5)
Reasons for living in Criciúma	
More job opportunities	14 (35,0) [2]
Always lived there and likes it	10 (25,0)
Family reasons	7 (17,5)
Does not live in Criciúma	5 (12,5)
Good place to live	3 (7,5)
Unable to provide an opinion	1 (2,5)

[1] The data was obtained through the ANOVA test..
[2] The data was obtained through the likelihood ratio test.
Source: Research data

Based on the analysis of Table 2, it can be observed that the average age of professionals in the construction industry studied is 43 years, as the majority of workers fall within the age range of 46 to 55 years. This fact can be correlated with the pursuit of this employment alternative, based on the educational level that did not extend beyond elementary school. It immediately highlights the need for higher remuneration over fulfilling educational qualifications during the corresponding time period of the respondents.

The majority of respondents come from the southern region of Santa Catarina state and sought the city of Criciúma primarily for better job opportunities, while others chose to stay in the area.

After collecting personal data, the professional background of the participants was explored, with a focus on the reasons that led them to pursue a career in the construction industry, whether they always wanted to work in their current profession, and their learning process. The Table 3 shows the statistics of responses regarding motivation for the profession and career path of the participants.

Table 3: Motivation for profession and career path

Variable	Mean ± Standard Deviation or n(%)
	n = 40
Age at which you started working in this role (years)	20,35 ± 6,89[1]
Age range (years)	
Up to 15	7 (17,5)[2]
16 to 25	29 (72,5)
26 to 35	3 (7,5)
> 46	1 (2,5)

Reasons that led you to become a mason	
Family encouragement	12 (30,0) [2]
Only option available at the time	12 (30,0)
Salary	9 (22,5)
Identified with the job	5 (12,5)
Didn't want to study	2 (5,0)
First mentor	
Work colleagues	17 (42,5) [2]
Family members	14 (35,0)
Did not have one	9 (22,5)
Was being a mason always part of your life plan?	
No, wanted to pursue another profession	19 (47,5) [2]
Yes, always enjoyed the job	11 (27,5)
No, wanted to study for a better job	7 (17,5)
Unable to provide an opinion	3 (7,5)
How was the learning process?	
Learned easily	12 (30,0) [2]
Learned on their own, with great effort	11 (27,5)
Started as a laborer and gradually learned the trade	8 (20,0)
Learned from family members/colleagues	6 (15,0)
Faced difficulties in learning	3 (7,5)

[1] The data was obtained through the ANOVA test..
[2] The data was obtained through the likelihood ratio test.
Source: Research data

It can be observed that the majority of workers started in this role at a very young age, with an average of 20.35 years, falling predominantly within the age range of 16 to 25 years. The main reasons for entering this profession were family encouragement or a lack of other opportunities. Most professionals learned the trade easily from their colleagues and had intentions of pursuing a different profession than that of a mason.

Continuing with the general characteristics of the sample, the workers were also asked about their personal opinions regarding their work environment and their supervisor, as well as their views on the amount of waste generated and possible proposals for its management and reuse.

Tabela 3: Workers' perception of the generated waste

Variable	n (%)
	n = 40
Define your job and the engineer's job on the construction site	
The foreman communicates between the masons and the engineer	23 (57,5) [1]
Has contact with both the engineer and the foreman	15 (37,5)
Interns and foreman oversee the work, and the engineer notes any irregularities	2 (5,0)
What is your opinion about the waste generated?	
Reasonable	12 (30,0) [1]
Can be avoided	11 (27,5)
Minimal	7 (17,5)
Excessive	5 (12,5)
Can be reduced but not reused	1 (2,5)
Can be reused	1 (2,5)
Unable to provide an opinion	3 (7,5)
What would you do to reduce the amount of waste?	
Reuse	8 (20,0) [1]
Recycle	7 (17,5)
Use as aggregate	4 (10,0)
Use as landfill	4 (10,0)
Not possible to reduce	4 (10,0)
Challenging, but possible	3 (7,5)
Raise awareness among workers	3 (7,5)
Incorporate sustainable materials into the project	2 (5,0)
Unable to provide an opinion	5 (12,5)
What would be an ideal city for you?	
Job opportunities	18 (45,0) [1]

Safety	11 (27,5)
Health	10 (25,0)
Respect	9 (22,5)
Education	5 (12,5)

[1] The data was obtained through the likelihood ratio test.
Source: Research data

In most cases, the foreman acts as the communication interface between the masons and the engineer. Regarding the construction waste, a large number of respondents believe that the amount generated is reasonable, bordering on waste, and can be reused. When asked about their ideal city, the majority expressed a desire for more job opportunities.

Furthermore, the data from the previous tables were cross-referenced to expand the statistical inferences on the collected information. Considering the density of information, the following are interpretative considerations based on the data. Observing the current ages and the ages at which they started in their profession, it is clear that the main motivation in both situations is to support their families financially, which is also reflected in their current responses. The level of education influenced the professionals' motivation significantly, as those with only a complete elementary education were primarily motivated by their families, while those with a higher level of education (completed high school) were equally motivated by the lack of other options and salary considerations.

Among the regions with the greatest influence on the data, professionals from the southern region pursued this profession because it was the only alternative available, while those from other states sought this option due to better salaries. Those who sought more job opportunities saw this profession as their only option, and those who have always lived in the city did so for family reasons.

Analyzing the data regarding who taught them the trade, it can be inferred that having a first mentor is coincidental and unrelated to the personal and professional characteristics of the workers. Interestingly, there is evidence of hierarchical levels of learning reflected in the responses, culturally applied by the masons themselves. Based on the analyzed data, it can be inferred that the level of education does not influence the complexity of learning this profession, as it is essentially a practical activity that relies on intuition rather than theory. The learning process depends on the individual worker, as most of the data confirms that those with less access to theoretical information learned through their own effort. Additionally, those who have specialized skills acquired them through on-the-job training.

People coming from other locations to work in this profession demonstrate greater ease in learning the trade, while those who entered this profession due to family reasons show a higher level of effort, indicating that those who need the opportunity make more effort to maintain their employment.

Regarding the comparison of data on life plans, it can be observed that individuals with lower levels of education see the construction industry as their only option for employment. The influx of individuals from other states seeking job opportunities reflects the limited employment opportunities, which affects both the local residents and those from other areas.

In terms of the relationship between the workers, managers, and engineers, it is apparent that the overall background of the worker, including education and origin, does not influence the type of relationship they have with the engineer. Regarding waste, workers who are older and have lower levels of education have a broader perspective and recognize that all waste can be avoided. Even those with higher levels of education do not pay as much attention to these factors. Interestingly, the individuals who opted for the most viable solutions are the older ones and those with lower levels of education. It can also be noted that none of the alternatives suggest addressing the root causes but rather focus on solving the consequences.

The majority of respondents do not prioritize health, even among those who are older. The highest incidences of respondents prioritizing health are from individuals who come from other states, while there is a lack of interest among the residents of the local region.

The data sample indicates that younger individuals prioritize more job opportunities, and those with a medium level of education have varying interests in this regard. Those who already lived in Criciúma balance their priorities between job opportunities, even among those who came to the region for this purpose.

Regarding the ideal city inquiries, it is important to note that the results differ significantly based on education level. It is worth highlighting that workers who live in Criciúma for family reasons prioritize respect as an important aspect of an ideal city, implying that this value is acquired through family life. The analyses conducted indicate that the respondents, regardless of age, origin, or other criteria, did not prioritize education in their ideal city model.

After collecting and analyzing the data on the current profile of construction workers, it is necessary to compare the findings with the information presented in the literature. Thus, various similarities can be observed between the results of this study and other studies conducted in the field of construction. For instance, Neri (2011) argues that the constant decrease in construction labor, coupled with the fact that current workers are older, is due

to young people seeking less physically demanding and more skilled occupations than those traditionally offered in the construction sector. Therefore, in addition to not employing women and having a low demand for men, even without requiring vocational education, the trend is an exacerbation of the labor shortage, precisely because the more educated individuals have not chosen to work in construction. This suggests differentiated wage increases for the sector, the need to adapt employed technologies to the new social context, and new perspectives for the old challenges of construction.

Regarding the level of education among the workers, SINDUSCON points out that the educational level is low, with the majority having only completed elementary school. Among those who have reached high school, most do not complete their education. This highlights a concern for the industry, emphasizing the importance of creating educational incentives within the sector.

The results presented by the Sindicato in 2016 also demonstrate that the majority of professionals are composed of masons (20.6%), laborers (18.5%), and carpenters (14.2%). In these same positions, the skills were learned within the workplace with the help of colleagues and superiors, due to the difficulty of finding qualified labor.

VI. Final considerations

Based on the analyzed data, it was observed that workers who are older (above 46 years old) sought the profession of mason due to a lack of better job opportunities, stemming from their lack of education. Overall, it was noted that these workers learned the trade on their own, through their own efforts, implying that necessity led them to be efficient in their respective roles.

Regarding the reduction of construction waste, through the conducted analysis, it is noticeable that older workers with lower levels of education have a broader perspective and recognize that all waste can be avoided. In other words, even those with higher access to education do not pay attention to these factors. It can also be observed that none of the alternatives suggest the solution to the cause itself, but rather the consequences. In other words, the focus is on resolving what the problem generates, rather than the problem itself.

The importance of the construction process for the Brazilian economy and employment of labor should also be emphasized. Construction is the second sector with the lowest participation in professional education, second only to agriculture. This means that due to not requiring high levels of education and allowing for easier access to learning operations, the current scenario employs workers who need jobs with low educational and professional requirements.

It is necessary to point out that construction workers tend to have high job satisfaction, but they also wish to expand their professional knowledge. This issue can be addressed by incentivizing workers, involving them in projects, and providing alternatives for professional training.

By employing educational incentives in the construction sector and involving employees in project stages alongside all hierarchical levels, professionals can feel valued and can share their tacit and explicit knowledge. This way, construction projects can be carried out more efficiently and effectively, while also creating space for the generation of sustainable ideas that will drive the reduction of construction waste.

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