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Cost Management: Standardization and Reduction of Losses in Public Civil Construction

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ABSTRACT
Over the last decade, civil engineering in Brazil has progressed in developing methodology and technology for the efficient use of material and financial resources available for a construction project in the private sector. However, concerning the public sector, resource usage continues to use practices that lead to waste, ultimately increasing direct and indirect costs. The overall objective of this research is to demonstrate how the use of cost control tools can prevent material waste and reduce unnecessary expenses within the context of public construction projects. Increasing efficiency in the use of material resources not only results in cost reduction but also helps avoid material waste that can harm the environment and avoid unforeseen expenses. The methodology adopted for the development of this research is characterized by a qualitative approach using the research procedure of a case study. The subject of this study is a public construction project in the State of Ceará, conducted between 2019-2022. According to the case study, we found that the more efficient use of available digital resources in the market can improve efficiency in material acquisition and its rational use, favoring the sensible use of public resources that come from taxes paid by citizens. The function of a public work is for the benefit of the population, fulfilling the social objective that prompted its construction.
Keywords*: Costs; Public Works; Waste; Control.*

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I. INTRODUCTION

Cost management in public civil construction projects is subject to influences and changes at every stage of its execution. From bidding to delivery, the procurement department of a public civil project is constantly adapting to avoid losses, excessive spending, and resource (material and financial) waste. Effective management not only aims to fulfill the project within the budget allocated but also includes social impact (jobs generated before and during the project), economic value (income generation for commerce - suppliers and ancillary services), and environmental impact (efficient use of materials and disposal or reuse of leftovers or debris) (Pinheiro, 2021) [1].

Difficulties in this management arise from the project design phase, which may fail to consider aspects that can impact execution and final cost. For instance, projects housing cultural facilities such as galleries and museums may have technical specifications for cooling, painting, conservation, and fire prevention that are much more sophisticated than those adapted to public buildings with administrative functions.

At another juncture, projects involving the restoration of historical buildings may encounter structural problems necessitating additional restoration demands. All of these factors directly impact the procurement sector, which must find suitable suppliers of materials and services.

Understanding how to manage the impacts of these costs, while minimizing losses and avoiding waste, implies forming a cohesive procurement sector aligned with the project's engineering department. Wrong or unnecessary purchases can be avoided, and surplus materials can be used efficiently.

During the COVID-19 pandemic, managing the procurement sector in a city where several sectors came to a halt, but public projects continued (except for a 15-day lockdown in 2020), brought unprecedented

experiences. Managing purchases that now included alcohol and masks in quantities not previously seen in the local market, for example. This variety of events underscores the need for standardized control in procurement management to avoid waste and unnecessary costs.

The methodology adopted for this research is characterized by a qualitative approach using the case study research procedure.

The general objective of this research is to demonstrate how the use of cost control tools can prevent material waste and reduce unnecessary expenses within the context of public projects. The specific objectives outlined are: to discuss project management and standardization in the procurement sector, to evaluate methods used to reduce losses and avoid waste in public civil projects, and to propose a standardization method in purchasing orders in accordance with the civil engineering department responsible for the project.

This article is organized into four sections. The first is the introduction, the second is the theoretical framework with subtopics on management and standardization in the procurement sector, evaluation of tools for waste control, and proposal for a standardization method in orders. The third section discusses the methodology employed in developing this article, and the fourth presents the concluding remarks.

II. MATERIAL AND METHODS

The methodology adopted for the development of this research is characterized by a qualitative approach, applied nature, descriptive objectives, utilizing the research procedure of case study. This research approach allows for a profound understanding of the study object, enabling contextualization and practical application of hypotheses. According to Creswell (1997), as cited in Maffezzolli and Boehs (2016, p.98), "I position case studies in the middle of the continuum [2]."

According to Maffezzolli and Boehs (2016, p.95), "The case study has been a method commonly employed in Brazilian academic research in applied social sciences, especially in Administration [2]." Studying unique characteristics of situations can provide insights into processes and may even foster theories, but it requires a neutral and objective perspective on the subject being analyzed.

For Maffezzolli and Boehs (2016, p.98), citing Creswell (1997), "[...] the notion of a bounded system is related to the definition of time and space, and the 'case' can be understood as an event, an activity, or individuals." Therefore, analyzing in depth the topic proposed in this project, the cost management of a public civil construction.

The period analyzed ranges from July 2019 to March 2022. Also, according to Maffezzolli and Boehs (2016, p.98), commenting on Yin (2005), there are three types of case studies: "(1) exploratory, (2) descriptive, and (3) explanatory (or explanatory)." In the case of this study, we opted for the explanatory type.

Among the authors who have contributed most to the development of this research, the following deserve mention: Boeriz and Gonçales Filho (2021); Dornelles, Lemes, and Nunan (2021); Araujo Junior and Silva (2022); and Saint Jean et al. (2022).

III. THEORETICAL FRAMEWORK

During the researcher's experience in a public civil construction project in the state of Ceará, between 2019-2022, specifically in the procurement department, difficulties in controlling waste in the purchase of inputs were observed. This situation led to reflection on the reasons for such difficulty, considering the existence of digital cost control tools. Moreover, all involved in the planning, management, conduct, and execution of the project have access to cell phones, email, and messaging applications (WhatsApp), with the latter often being more commonly used than phone calls and even emails. Additionally, there was extensive use of intercom radios among these same departments. However, often, this ease of communication did not translate into fluidity or accuracy of information. It was also noted that the Technical Office, responsible for project management and procurement requests, often did not have a real understanding of what had already been acquired in relation to the project's cost or its usage.

A public civil construction project demands financial, material, and human resources for at least 3 years before it is completed, depending on the type of project. Its objective has social and economic purposes, but it also has environmental and financial dimensions, requiring effective resource management. Therefore, standardization in the procurement of inputs and waste reduction are strategic and important; both in the use of financial resources, which suffer from political-administrative impacts of the governing body, and in the administration of the project's progress.

We live in a digital age, where transparency and efficiency in the use of public resources are no longer an option but rather an obligation. Everything is recorded and will be verified at some point. Standardization helps to identify bottlenecks and avoid losses, but also constitutes useful memory for other projects. Public projects are never exhaustive, as the population is constantly growing or evolving, where new projects or restructurings become necessary. Knowing what has been done, how, and how much it cost assists in the administration and execution of a new project with similar characteristics.

At another moment, the complexity of projects requires coordination among various parties, in addition to the procurement department, such as engineers, suppliers, transporters, and even regulatory agencies. Communication and coordination of actions may often be disrupted, resulting in delays and losses. Furthermore, lack of preparation among construction workers leads to losses due to misuse of inputs and/or machinery.

According to Pinho (2013, cited in Saint Jean et al., 2022, p.8), "factors causing waste in construction are associated with three categories: material selection (logistics), project leadership and control. In construction projects, it is very common for changes to occur due to client demands, resulting in rework and waste [3]." Requests for modifications throughout a public construction project directly impact its final cost, as they may include items not initially planned in the initial design or that were modified to adapt to unforeseen conditions, such as the COVID-19 pandemic.

According to Moreira (2019, p.756), issues within the project bring about flaws that are not always addressed during construction:

> Another important issue addressed in this study is the lack of compatibility between projects within the same construction, which occurs when projects are not completed before the construction begins. Problems start when new projects arrive, and the lack of compatibility with the previous project is noticed. For example, when the architectural project is not suitable for the engineering project, the search for adaptation begins, requiring the redesign of the project or technical arrangements, which gradually reduce the quality of the construction [4].

We seek to demonstrate that procurement sector control tools can not only prevent financial losses but, especially, material waste and improve their usage. The philosophy of "Lean Construction", originating from the Toyota Production System (TPS), focuses on reducing material waste, something that is recurrent in construction and poses an environmental hazard, causing monetary losses.

According to Shingo (1996, cited in Boeriz; Gonçales Filho, 2021, p.72), "The Toyota Production System (TPS) aims to increase production efficiency through consistent waste elimination [5]." In construction, managing to avoid waste also prevents the production of unnecessary waste that ultimately generates unforeseen costs in the initial design. According to Saint Jean et al. (2022, p.7), "project errors and poor resource management were cited most often as the items that consume the most time, followed by rework, waiting, and cargo movements [3]."

Furthermore, according to Boeriz and Gonçales Filho (2021, p.72), the TPS is based on the concept of the 4 P's (Philosophy; Process; People and Partners; and Problem Solving), and the 14 principles, including:

> (1) Base management decisions on a long-term philosophy, even at the expense of short-term financial goals; (2) Create continuous process flow to bring problems to the surface; (3) Use a pull system to avoid overproduction; (4) Level the workload (Heijunka); (5) Build a culture of stopping to fix problems, to get quality right the first time; (6) Standardized tasks are the foundation for continuous improvements and employee allocation; (7) Use visual control so no problems are hidden; (8) Use technology only if it is reliable and serves your people and your process; (9) Develop/train leaders for work, philosophy to teach other employees; (10) Create and develop exceptional teams that follow the company's philosophy; (11) Respect the external network of partners and suppliers, challenging them and helping them improve their processes; (12) Understand the situation better in the field (Genchi Genbtsu); (13) Make decisions slowly by consensus, considering all options, and implement them quickly; (14) Make organization a learning organization through reflection (Hansei) and enable continuous improvements (KAIZEN) [5].

According to the article by Boeriz and Gonçales Filho (2021), there are eight types of losses related to "Lean Construction". Among those identified, in public civil construction, the most common are: a) Losses due to waiting time; b) Losses due to unnecessary transport; c) Losses due to stocks; d) Losses due to human potential [5].

Guiding public civil construction to adopt Lean Thinking in its administration and execution would not only avoid waste but also favor the flow of orders more effectively and quickly. Avoiding wrong orders, unnecessary returns, and hiring inadequate suppliers. This should also include more effective training of construction workers in the rational use of available resources. In the following subtopics, it will be possible to observe theoretical foundations related to the subject at hand, with varied contributions from authors researching the same topic and practical reports from the entire experience of this researcher during the case study.

3.1 Construction Management and Standardization in the Procurement Sector

The management of a public civil construction project involves not only completing tasks but, above all, efficient communication among technical departments (engineering and design), the procurement department, and the worker management sector (foreman). What we observed was a mismatch caused by various factors that can be monitored by a team comprising at least one representative from each of the sectors mentioned above. It is not about creating a department within the organizational structure of a project but about improving communication and establishing a standard flow of procurement requests. According to Saint Jean et

al. (2022, p.8), "communication (insufficient or deficient) is truly one of the great villains of all projects, not only in civil construction [3]."

The procurement flow of the project in question followed as follows:

1. The procurement request generated by the demand from the Technical Office, composed of a team consisting of a civil engineer, architect, and civil engineering interns;
2. The procurement request was forwarded to the procurement department, which checked the inventory with the warehouse to determine if the required input was available, in what quantity, and its expected usage. In urgent requests by the Technical Office managers, there was not enough time for this verification, consequently resulting in distortions in the inventory (excess of inputs).
3. This flow could be influenced by the client government - SOP (Public Works Secretariat) and the office responsible for the project, but both addressed the Technical Office to adjust the request.
4. After the necessary checking and/or addition/change in the procurement request, the procurement department proceeded with the acquisition of what was needed.

According to Batran (cited in Dornelles; Lemes; Nunan, 2021, p.3), "buyers assume value chain manager responsibilities, [...] being the main contributor to companies' competitiveness [6]." According to Dias (cited in Dornelles; Lemes; Nunan, 2021, p.3), the procurement department has the duty to "provide the correct quantity at the right time, and also to monitor whether the product/service was delivered correctly as expected [6]." In this particular project, there was also the issue of financial flow (government funding), which could accelerate or delay the progress of the project. Procurement of inputs or services that depended on others to be used in the project, but for which there was no financial provision yet, could result in losses depending on the material (if it was more sensitive or perishable).

Strategically, the procurement department "is responsible for collecting and analyzing information about suppliers [...], to allow the selection of those that best meet the requirements," according to Oliveira (cited in Bezerra et al., 2020, p.02) [7]. Price, delivery, reliability, and quality are items that vary in priority depending on the input or service.

At a certain point in the construction, the procurement department also became responsible for repairing and maintaining portable machinery used in the project. In this aspect, the lack of preparation of the workers to handle machinery was evident, not because of its technology per se but because of the improper use even after correct training. The stubborn notion that "instruction manuals are not useful" or that "I had used it differently before and it worked," were some of the reports recorded at the time. The same notion was observed regarding work with some materials, where excessive use caused waste or improper use caused rework.

For example, the project had 12 10 kg breakers for general use. On average, 1 to 3 of these breakers would break daily and go for maintenance. Due to this high breakage rate, mostly due to misuse, there was a need to have a stock of equipment to prevent work interruption. This type of equipment is rented, so even if not used at the moment, the equipment remained in the warehouse as a reserve in case of breakage.

The procurement of inputs, even when conducted in the best possible manner, was not able to prevent material waste, but efforts were made to minimize the cost generated with the following actions: a) redirection of material to another project, b) reuse in the project, c) proper environmental disposal, or d) stock for future use in the project or elsewhere.

According to Salgin; Arroyo, and Ballard (cited in Araujo Junior; Silva, 2022, p. 3), there are two types of waste:

> The first type consists of direct residues, which are losses of materials that were damaged and later salvaged or lost during construction. The second is indirect waste, which was distinguished from direct waste because it is a monetary loss and the materials were not physically lost [8].

The waste destination may not always eliminate or minimize the monetary loss. This choice may vary depending on the project stage, the type of waste, and local receipt or recycling services.

3.2 Evaluation of Tools for Waste Control

According to Dornelles, Lemes, and Nunan (2021, p.1), "the ability to absorb new market techniques can interfere with a company's competitive potential [6]." Empowering users to understand and operate tools for waste control is more than a market necessity; it is also an awareness that resources are limited, and the impact caused by material waste has consequences for the environment and the cost of a project. According to Araújo Junior and Silva (2022, p.02), it is "necessary to act from conception to the implementation phase of a project to try to avoid or reduce waste generation."

The Informakon, a software by Konstroi, was used from the beginning of the study project. The initial training was not easy, and it was observed that some aspects of project management were not covered in the system. However, once its use was understood, it became an ally in visualizing the project's cost, in the procurement sector, and also facilitated financial control by the directors of the construction companies that

comprised the consortium responsible for the project. In the case of this project, we used the Standard version, which includes the following features: engineering, procurement, inventory, finance, and commercial.

According to Martínez-Rojas, Martín, and Vila (cited in Azevedo, 2022, p.14), "although civil construction projects are considered highly complex, they are typically marked by lack of integration and fragmentation in their management [9]." In this scenario, Informakon helped integrate complex areas and share information with sectors that were in different locations on the construction site. However, it has limitations, so the communication flow needs to be more efficient and regular. This communication aims not only at the progress of the project but also at creating learning for the involved sectors and the responsible companies, which thus gain expertise for similar projects, experience required in public tenders.

Azevedo (2022, p. 39) reports in his research that "employees cite the lack of communication between sectors as a difficulty factor in processes [9]." The lack of interaction is repeated on the construction site, especially when there is more than one foreman and teams in different sectors of the project. Furthermore, we verified resistance to new learning related to procedures in the use of inputs and machinery. With each problem occurrence, it was necessary not only to solve it quickly but also to use clear, direct, and easy language to correct wrong or inefficient handling.

According to Moreira (2022, p.758), "[...] the problems in the construction sector are not only related to the lack of qualified labor in the market, but also to problems in the recruitment and selection process that are carried out inadequately, without the necessary criteria to ensure that the appropriate professional is being hired [4]."

The procurement department does not interfere with labor recruitment, but it can contribute to practical training to avoid or minimize waste.

IV. RESULTS

4.1 Proposed Method for Standardization in Purchase Orders

We cannot overlook the importance of planning for better project management and standardization of purchases in a construction project. According to Moreira (2022, p. 759), "inefficient or flawed planning is another problem faced in the construction sector. Sometimes errors are found in the quantity of necessary materials [...] causing delays and errors in the schedule, or even problems in the structure built. Thus, the impacts on results are inevitable [4]."

Oliveira (cited in Moreira, 2022, p.760) further adds that "incompatibility [...] occurs from the initial stages of the project and can be justified by the lack of use of support software or by the overload of functions on the engineer [...] [4]." Additionally, when dealing with a public civil construction project, the original project may have been drawn up years before its execution, by an office unrelated to the company that will carry out the construction. This situation requires appropriate changes to be made during construction (using more modern materials, other models), as well as changes related to the construction site and its conditions (topography, water and sewage connections, terrain conditions). For example, when various historical items were discovered, prompting archaeological investigations at the construction site, which led to the suspension of activities in certain areas and the hiring of an archaeological investigation service.

According to Menezes and Marinho (2023), "In the context of civil construction, it is possible to synthesize these methodologies in order to create a more productive and organized construction site, finishing the services more safely and within the proposed schedule, eliminating waste of materials and supplies, identifying possible project failures in advance, and raising the quality of the service to be delivered to the client."

To correct or minimize the waste described in this work, standardization should include two main aspects: knowledge of the executed project and the available material inventory, and regular communication with the technical department responsible for the project and the foremen. The procurement department in a public civil construction project should start playing a regulatory and mediating role, which requires employees with technical-educational, technological, and personal preparation.

For the first item mentioned above, the effective purchasing flow should include integration with the following items or departments of a public civil construction project:

1. The original project of the work, from its bidding, to be familiar with the scope, schedule, and planned planning;
2. Technical Department that will conduct the project, a department composed of engineers, architects, and engineering interns, responsible for mediating between the client (government) and the procurement department;
3. Warehouse of the construction site and the construction company, to know what material already exists, if it is adequate, or if it can be relocated.

Avoiding unnecessary purchases brings advantages to project management not only in monetary terms but also creates space (physical and financial) for urgent orders that arise from changes in the project or from adversities, such as the pandemic, archaeological findings, and thefts suffered (theft of electrical cables, among other materials).

For the second item, regular communication, a routine of regular communication must be established involving the following professionals:

1. Civil engineer (or team of engineers) who will conduct the project;
2. Foreman, as they report to the engineering team and perform on-site monitoring of tasks, use of inputs, and machinery;
3. Warehouse keeper of the construction site, to control not only inventory but also the arrival and departure of materials.

The flow of a purchase should then follow the following steps:

- Technical Department generates the request through Email or WhatsApp to the Procurement Department;
- Procurement Department checks with the warehouse (via radio, WhatsApp, or Email) for the existence of the material, its quantity, and average usage. If the material exists, the information is reported to the Technical Department for review of the quantity or to confirm the need for purchase;
- Procurement Department checks with the Technical Department and/or the Foreman when they will need the material in question. Whether or not the material is available in the warehouse, it is also important to know when the material will be used to verify if the supplier's delivery time is adequate or if another supplier offers a shorter time, even if there would be another supplier;
- Procurement Department makes the purchase after checking the information.

In addition to this flow, the purchase is registered in the management software used so that other departments can check and/or follow up. The organization of the procurement department should favor transparency and easy access to information, as well as facilitate integration with other project departments.

In preventing waste, the procurement department should also be aware of what to do in case of excess and/or debris. Again, communication with the technical department is essential.

The decision-making regarding excess material, whether it is more viable to try to sell it (to whom, for how much), return the material (if the supplier accepts it, transportation), or if it is worth stocking it for future use in the same project or in another one (suitable location, how long it can be stored).

The issue of debris, for its classification and proper disposal, provided that recycling services or material receiving services are available. This is a decision flow that requires communication but also standardization to avoid schedule delays and unwanted accumulation.

V. DISCUSSION AND CONCLUSION

The examination of cost management, standardization of procurement processes, and waste reduction strategies in public civil construction projects underscores critical areas where improvements are necessary to ensure project success and resource optimization. Through an in-depth analysis of the proposed method for standardization in purchase orders and its implications, several key points emerge for discussion and eventual implementation.

Firstly, the findings highlight the pervasive challenges inherent in public civil construction projects, including inefficient planning, discrepancies in project scope, and inadequate communication among project stakeholders. These challenges contribute to delays, errors, and material waste, underscoring the need for standardized procurement processes and effective coordination between technical departments and procurement teams.

The proposed method for standardization in purchase orders addresses these challenges by establishing clear communication channels, integrating project stakeholders, and implementing transparent procurement workflows. By aligning procurement activities with project requirements and inventory management, the method aims to minimize unnecessary purchases, optimize resource allocation, and enhance project efficiency.

Furthermore, the emphasis on regular communication and collaboration between civil engineers, foremen, and warehouse keepers reflects a proactive approach to material management and usage. By fostering a culture of accountability and transparency, project teams can mitigate the risks associated with excess materials, disposal issues, and schedule delays.

The discussion also acknowledges the broader implications of standardized procurement processes beyond individual projects. By leveraging digital tools, such as management software, and adopting lean construction principles, construction companies can enhance operational efficiency, reduce waste, and improve overall project outcomes. Moreover, the dissemination of best practices and lessons learned from standardized procurement initiatives can contribute to industry-wide improvements and innovation.

In conclusion, the implementation of standardized procurement processes represents a critical step towards achieving cost efficiency, resource optimization, and sustainability in public civil construction projects.

By embracing the proposed method and fostering a culture of continuous improvement, construction stakeholders can navigate the complexities of project management, mitigate risks, and deliver value to stakeholders and communities.

In summary, the discussion underscores the importance of proactive measures, effective collaboration, and adaptive strategies in addressing the challenges of cost management and waste reduction in public civil construction projects. Through a commitment to standardized procurement practices and continuous improvement, construction stakeholders can unlock new opportunities for innovation, efficiency, and long-term success in the dynamic construction landscape.

REFERENCES

[1]. Pinheiro, I. (2021). Construction budget: Understand the types and when to use them! Fortaleza: Inova Civil.

[2]. Maffezzolli, E. C. F., & Boehs, C. G. E. (2016). A reflection on the case study as a research method. Revista da FAE, 11(1). https://revistafae.fae.edu/revistafae/article/view/262.

[3]. Saint Jean, G., Longo, O. C., & Lima, G. P. (2022). Sustainability and planning applied in civil construction from the perspective of professionals. Research, Society and Development, 11(5), e9611527864. https://doi.org/10.33448/rsd-v11i5.27864.

[4]. Moreira, S. G. (2019). Best practices to reduce cost deviations and delays in civil construction projects. Revista Eletrônica Produção & Engenharia, 9(2), 754–763.

[5]. Boeriz, T. A., & Gonçales Filho, M. (2021). Quality management in waste prevention at a civil construction site. Brazilian Journal of Production Engineering, 7(3), 71–84. https://periodicos.ufes.br/bjpe/article/view/35827.

[6]. Dornelles, N. F., Lemes, M. E. A., & Nunan, C. S. (2021). Sourcing 4.0: A case study on the challenges of implementing electronic supplier management in a steel company. XLI Encontro Nacional De Engenharia De Produção, Foz do Iguaçu.

[7]. Bezerra, R. R. R., Mendes, B. G. R., Melo, A. C. S., & Castro, G. S. (2020). Proposal of a methodology for evaluation and selection of suppliers in a timber industry: An approach based on Analytic Hierarchy Process. XL Encontro Nacional de Engenharia de Produção, Foz do Iguaçu.

[8]. Araujo Junior, C. A., & Silva, R. F. (2022). Lean construction philosophy for reducing losses of ready-mixed concrete applied in a project in the city of Paulista – PE. Instituto Federal de Pernambuco. Retrieved from https://repositorio.ifpe.edu.br/xmlui/bitstream/handle/123456789/943/Filosofia%20lean%20construction%20para%20redu%C3%A7%C3%A3o%20de%20perdas%20de%20concreto%20usinado%20aplicada%20em%20uma%20obra%20na%20cidade%20de%20Paulista%20%E2%80%93%20PE.pdf?sequence=1&isAllowed=y.

[9]. Azevedo, C. D. (2022). Knowledge management and lessons learned in civil construction: A case study. Retrieved from https://repositorio.ufpe.br/bitstream/123456789/48603/1/DISSERTA%C3%87%C3%83O%20Clarissa%20Dalia%20de%20Azevedo.pdf.

[10]. Menezes, L. L. F., & Marinho, F. J. E. (2023). Lean construction: The use of quality management through the implementation of planning and control tools in civil construction. Revista FT, 28(128). Retrieved from https://revistaft.com.br/construcao-enxuta-o-uso-da-gestao-da-qualidade-atraves-da-implementacao-de-ferramentas-de-planejamento-e-controle-na-construcao-civil-2/.