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METHODOLOGY TO AVOID THE OCCURRENCE OF MAKING-DO WASTE IN CIVIL CONSTRUCTION

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ABSTRACT

The scenario of the Civil Construction industry is highlighted by the very high level of production waste, waste generation, and non-value-added activities. Among the array of existing waste types, one significant category is making-do waste, which gives rise to the following consequences: reduced productivity, reduced worker safety and motivation, reduced quality, and rework. The proposed model aims to contribute to efficiency and competitiveness in civil construction by filling gaps in loss management through making-do. Therefore, this study proposes a methodology based on establishing guidelines aimed at avoiding waste due to improvisation by addressing their root causes. To this end, we aimed to analyze a database containing a survey specifically focused on making-do waste at construction sites. A sample of 420 different kinds of waste was obtained, and 47 different guidelines applied to different work stages were created. The guideline with the highest number of occurrences was "Perform verification and inspection from the FVS before, during and after the execution of the service," while the most substantial number of propositions referred to waste whose missing prerequisites were "Information" and "Labor." When applied to the proposed methodology, these guidelines can become a strategic tool combined with production management that is aimed at minimizing waste.

KEYWORDS

Making-do waste; Guidelines; Production management; Civil Construction.

INTRODUCTION

The construction industry has always faced problems regarding deadlines, cost overruns, and waste generation, imposing negative impacts on the environment and excessive consumption of resources (Hussin et al., 2013). In general, it is assumed that there is a very high level of

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waste/non-value-added activities in construction. Moreover, several studies have confirmed that waste in the construction industry represents a relatively large percentage of the production cost (Aziz; Hafez, 2013).

However, waste in civil construction extends beyond the waste generated and can be understood as any inefficiency reflected in the use of materials, labor, and equipment in quantities surpassing what is necessary for building production (Santos et al., 1996).

A possible application to improve performance in construction processes while minimizing costs is applying the lean production system (Yücenur; Kaan, 2021). The principles of the Toyota Production System, developed by Ohno (1988), can be considered a major precursor of Lean Manufacturing. Koskela (1992) proposed the application of a new philosophy called Lean Construction in the construction sector.

The philosophy of Lean Construction proposes reducing waste and improvisations in production in search of a product of higher quality and lower cost (Santos; Santos, 2017). As a result, lean construction incorporates many dimensions and techniques that have become synonymous with lean production, such as just-in-time delivery, value stream mapping, and continuous process improvement (Small; Al Hamouri; Al Hamouri, 2017).

Ohno (1988) further expanded this work by identifying and categorizing the types of waste in production, divided into the following categories: waste of overproduction, waste of time on hand (waiting), waste in transportation, waste of processing itself, waste of stock on hand (inventory), waste of movement and waste of making defective products. In the context of civil construction, Koskela (2004) presents a new type of waste called making-do.

The term making-do is defined as the act of starting a task without ensuring that all necessary inputs (materials, tools, machines, people, external conditions, and information) are accessible or when the task continues to be executed despite one of the inputs being missing causing improvisations to occur in the execution of the service (Koskela, 2004).

According to Koskela (2004), among the consequences of making-do waste, the main highlights are reduced productivity, reduced worker safety and motivation, reduced quality, and rework. The investigation of different types of waste and their impact on the cycle time of construction processes has also been studied by other authors, for example, Sommer (2010) and Fireman (2012).

Despite lean philosophies being an emerging phenomenon in manufacturing and construction project management, the construction industry still needs to work on utilizing its full benefits, whether due to a lack of awareness or lack of application of clear strategies (Aslam et al., 2020). Measures to prevent or mitigate making-do waste processes have not yet been identified in the literature.

Previous works by Braga (2018) and Maciel (2020) addressed the identification and analysis of making-do waste. Amaral (2019, 2021, 2022) carried out studies on making-do waste together with a research group; in 2022, the author conducted research on a significant waste database to analyze the relationship between prerequisites, categories, and impacts.

Amaral et al. (2023) pointed out that only surveying losses due to making-do does not provide enough information for managers to completely prevent these losses from occurring in their next undertaking or task. According to the authors, a mere evaluation of impacts caused by 'making-do' waste is insufficient for a manager to prevent such issues in future ventures or tasks. However, it enables a more comprehensive and interactive information analysis to mitigate these different types of waste. The conclusion is that instead of directing efforts towards rectifying all incidents identified onsite, managers could optimize resources by focusing on stages, teams, and processes with the most significant impact, cost, or project delays. These efforts should include workforce retraining, investing in design and selecting materials and components to align with project specifications, adopting medium-planning methods to eliminate constraints, and ensuring continuous flow between interdependent tasks. Furthermore, it is crucial to evaluate risks related to the consequences of rework, which are directly associated with reduced productivity, material waste, unfinished work, and a decline in quality.

By continuing this area of research, the present work aims to fill a significant gap: namely, establishing guidelines to avoid the occurrence of making-do waste associated with a methodology for its application, that is, to define direct strategies to prevent the occurrence of making-do in the Civil Construction cycle. Such a strategy can help decision-making and assist in the production process at construction sites.

METHOD

This research was classified according to its approach, nature, objectives, and procedures.

Regarding the approach, the research is classified as qualitative, as the data will be analyzed and processed initially in a standardized spreadsheet, and subsequently, classifications and guidelines will be suggested.

Regarding the nature of the work, the research is applied because it is aimed at applicability in the construction industry, suggesting improvements in the analysis processes and waste reduction in construction sites.

Regarding the objectives and procedures, the research is classified as exploratory, as it aims to address the phenomenon under study and provide data and analysis to expand on previous and subsequent research.

The data was extracted by a research group comprising experts in production management, working in the construction market as Civil and Production Engineers responsible for on site decisions, as well as master's students from the Production Engineering Postgraduate Program at the Faculty of Science and Technology, and undergraduate students in Civil Engineering from the School of Civil and Environmental Engineering.

RESEARCH DESIGN

The study methodology for developing the work was designed in 5 stages presented in the flowchart in Figure 1.

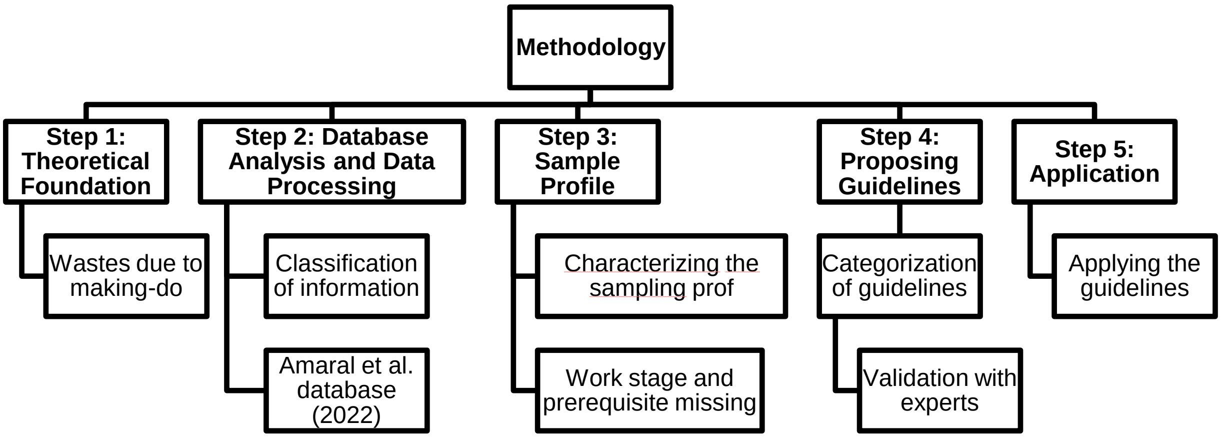

Figure 1: Research execution stages (Figure 1 source: the authors)

In Stage 1, the theoretical basis of the work was addressed, starting by studying the classification of different types of waste in the construction industry, their definitions due to making-do, and the reading of works developed to propose guidelines to minimize waste.

In Stage 2, we sought to process the database to identify the different kinds of making-do waste in 27 projects. The information refers to the database analyzed by Amaral (2022) and the survey carried out by the same research group in 2022.

The different types of waste identified in the projects by the research group encompass several processes, teams, and stages, which involved some research instruments such as questionnaires to characterize the companies, construction sites, and projects; questionnaires to investigate the planning process, semi-structured interviews carried out with production managers, members, directors; as well as document analysis (photos, drawings, drafts, notes, and documents) and web and mobile inspection tools (Amaral et al., 2019, 2022, 2023).

The study database surveyed 7,448 different types of making-do waste, already classified according to the work team involved, prerequisite, category, and impact, in addition to the problem description. To process the information, data lacking clear and complete descriptions of the loss were discarded. This was essential to ensure that the proposed guidelines could effectively manage the causes and impacts generated.

By considering the stage, sub-stage, and category associated with the loss, we were able to identify recurring instances of the same problems in the different studies. Thus, this approach allowed us to focus on analyzing the activities and identifying the missing prerequisites for the loss. As a result, we compiled a sample of 420 instances of waste, each occurring under different stages, sub-stages, and prerequisite conditions, drawn from 19 projects involving 15 companies.

Table 1 presents the characterization of the participating companies, designated by letters “A” to “O.” Information about companies and works from “A” to “K” refers to the database analyzed by Amaral (2022), while the other companies are part of the survey carried out by the research group in 2022.

Table 1: Characterization of companies (Table 1 source: the authors)

Company	City	Time in the market	Certifications	Company size
A	Goiânia -GO	15 years	-	Midsize
B	Goiânia -GO	40 years	PBQPH-level A	Large
W	Goiânia -GO	29 years old	ISO 9001:2015	Large
D	Goiânia -GO	24 years	ISO 9001:2008 and PBQPH- level A	Large
AND	Fortaleza-CE	39 years old	ISO 9001:2015 and PBQPH- level A	Large
F	Fortaleza-CE	40 years	-	Large
G	Goiânia -GO	24 years	ISO 9001:2008, ISO 14001:2004, OHSAS 18001:2007 and PBQPH- level A	Large
H	Goiânia -GO	22 years	ISO 9001:2008 and PBQPH- level A	Large
I	Goiânia -GO	35 years	ISO 9001:2015	Large
J	Tournefeuille - France	20 years	French Standardization Association AFNOR ABNT ISO 9001: 2015 and AFNOR ISO:14001	Midsize
K	Goiânia -GO	19 years old	PBQPH- level A	Large
L	Fortaleza-CE	14 years	-	Large
M	Fortaleza-CE	54 years	-	Large
N	Fortaleza-CE	15 years	PBQPH- level A	Large
O	Fortaleza-CE	-	-	Large

In Stage 3, the sample profile was characterized, observing the construction stage and the missing prerequisite of loss due to making-do. To help identify guidelines at different stages of the development of the work, Table 2 lists the steps considered in the database used with their sub-steps to better understand the scope of each activity analyzed.

Table 2: Steps listed in the database used and their respective sub-steps (source: the authors)

STAGE	SUB-STEPa
Coverings and Linings	Plasterboard Linings and Wooden Structure for Covering.
Hardware and Glass Frames	Smooth Transparent Glass, Wooden Frames, and others.
Structure	Superstructure, Infrastructure, and complementary works.
Facade	Facade Plastering, Ceramic Facade Coating, Facade Plastering, Facade Scaffolding, and Suspended Life-Saving Trays.
Waterproofing and Treatments	Kitchen waterproofing Drain waterproofing.
Infrastructure and Complementary Works	Reinforcements and Consolidations of Foundations, Deep Foundations, and Preparation of Foundations
Fire Fighting Installations	Fire extinguishers.
Installations and appliances	Electrical installations, Additional installations, Appliances and metals, Records, Countertops.
Electrical Installations	Boxes and Control Panels Wires and Cables Conduits Sockets and Switches Piping.
Sanitary, Hydraulic and Gas Installations	Sanitary Sewer Pipes and Connections, Cold Water Pipes and Connections, Piping
Temporary Installations and Machinery	Life Trays, Elevator with Tower/Cabin/Winch, Lifeline, Guardrails Deposits/Office, Temporary Water Installation Facade and Suspended Scaffolding, Work Location, Temporary Power Entry, Rack.
Cleaning and Transport	Permanent Cleaning and Cleaning of the Work.
Carpentry and locksmithing	Closing of Shafts, Fire Doors, Forms, Hood.
Other Facilities	Air Conditioning Installation, Elevator Installation, and Others.
Walls and panels	Masonry and panels, Frames and hardware Block Masonry, Solid Bricks, Plaster Plaster, Mortar Coatings, Contramarco, Internal Plaster Partition, Cobogó.
Skirting and Sill Flooring	Steps and Landings Straightened Concrete Subfloor Ceramic Skirting, Carpets and Rugs Ceramic Coverings/Tile Sills.
Coatings and finishes	Joinery and metalwork, Flooring, Coatings, Linings, and decorative elements.
Coatings and Paintings	Mortar Coatings, Ceramic/Tile Coatings, PVA Painting and Grouting.
Initial Services	Technical services, Machines, and tools.
Preliminary Services	Demolitions Licenses/Fees/Registrations.
Technical services	Architectural Project, Hydrosanitary Project, Structural Project, Electrical/Telephone Project.
Superstructure	Reinforced Concrete and Forms.
Land work	Manual Excavations.

In Stage 4, the guidelines were proposed, in which we sought to consolidate all the results found and define the guidelines. These classifications will support systematic analyses of the guidelines to minimize the causes of wastes.

The guidelines underwent a validation process involving a production management specialist, who addressed queries and suggested improvements. Once the adjustments had been made, the guidelines were taken to a second validation stage, in which the research group was responsible for collecting and organizing the losses that comprise the database used. Four group members took part in a formal validation meeting and suggested adjustments and improvements, which were accepted and, finally, the guidelines were validated. Table 3 below shows the guidelines drawn up for each project stage.

Stage 5 involves applying the guidelines proposed in the construction industry cycle based on a workflow suggestion applied to production management on the construction site

Table 3: Table with examples of guidelines drawn up for each stage of work (source: the authors)

PHASES	SOME SUGGESTED GUIDELINES
Walls and Panels	Training of labor on square, plumb and levels and trims, their checks, tolerances, and limits
Structure	Provide feedback on decision-making regarding the execution of the work. This information must be passed on to the responsible designers and registered as As Built.
Installations and appliances	Carry out training with employees on the use of materials within the quality standards of the service execution procedure, as well as verification by a responsible professional during the execution of the activity.
Coatings and finishes	Perform effective protection of definitive items and finished services
Temporary installations and machinery	The equipment maintenance plan, a daily safety checklist, and operation criteria must be implemented.
Coatings and Paintings	Application of FVM by sampling in all deliveries;
Superstructure	Make sure to carry out not the minimum number but the necessary number of geotechnical tests to obtain the best possible knowledge of the soil.
Flooring, Skirting, and Sills	Monitor FVS, concreting maps, and technological control tests
Electrical installations	Implementation of EPCs and PPE
Initial Services	Create a checklist or use software to list all the official documents required for the work and relate them to their expiration date, renewal period, and revisions.
Facade	Material request planning
Complementation of the Work	Inspect the workplace to allow activities to begin when the impacts of the activity on the work area must be assessed.
Infrastructure and Complementary Works	Carry out verification and inspection from FVS before, during, and after performing the service.
Hydraulic, Sanitary, and Gas Installations	Predict the positioning of all pipes before concreting components

Table 3 (continued): Table with examples of guidelines drawn up for each stage of work (source: the authors)

PHASES	SOME SUGGESTED GUIDELINES
Technical services	Carry out alternative planning for critical cases in which the execution of services is prevented due to unforeseen conditions, listing alternative companies and machinery that could meet the new needs of the work.
Device Installation	Plan an executive service procedure that optimizes the tasks and executive sequence requested in the project.
Cleaning and Transport	Conduct training with employees and implement procedures for ending work, cleaning, and organizing the workplace.
Carpentry and locksmithing	Develop procedures for operating equipment and verify project information and guidelines in accordance with NR18.
Other Facilities	Make sure there is compatibility and clash detection of all subjects
Preliminary Services	Carry out periodic training of the workforce (monthly or bimonthly) according to the greatest needs and execution flaws, promoting qualification and also generating social value for the enterprises.
Frames, Hardware, and Glass	Make sure that the most updated and corrected version of the project is on-site and that it has all the information necessary to carry out the service, site on-site, and that it has all the information necessary to carry out the service before releasing the start of its execution.
Coverings and Linings	Carry out training with employees on the use of materials within the quality standards of the service execution procedure, as well as verification by a responsible professional during the execution of the activity.
Waterproofing and Treatments	Carry out verification and inspection from FVS before, during, and after performing the service.
Fire Fighting Installations	Carry out an inspection before starting activities, check the comfort and safety of the workplace, as well as training to issue the work permit.
Land works	Make sure that the most updated and corrected version of the project is on-site, and that it has all the information necessary to carry out the service before releasing the start of its execution.
Technical services	Carry out alternative planning for critical cases in which the execution of services is prevented due to unforeseen conditions, listing alternative companies and machinery that could meet the new needs of the work.
Device Installation	Plan executive service procedure that optimizes the tasks and executive sequence requested in the project.
Cleaning and Transport	Conduct training with employees and implement procedures for ending work, cleaning, and organizing the workplace.

RESULTS AND DISCUSSIONS

Based on the analysis of 420 different types of making-do waste, it became feasible to verify the work stages with the highest occurrences. Figure 2 shows the steps and number of different types of waste identified.

Based on the approach proposed in characterizing the sampling profile, the missing prerequisite responsible for the occurrence of each loss was verified. Figure 3 presents the prerequisites of the data studied for proposing the guidelines.

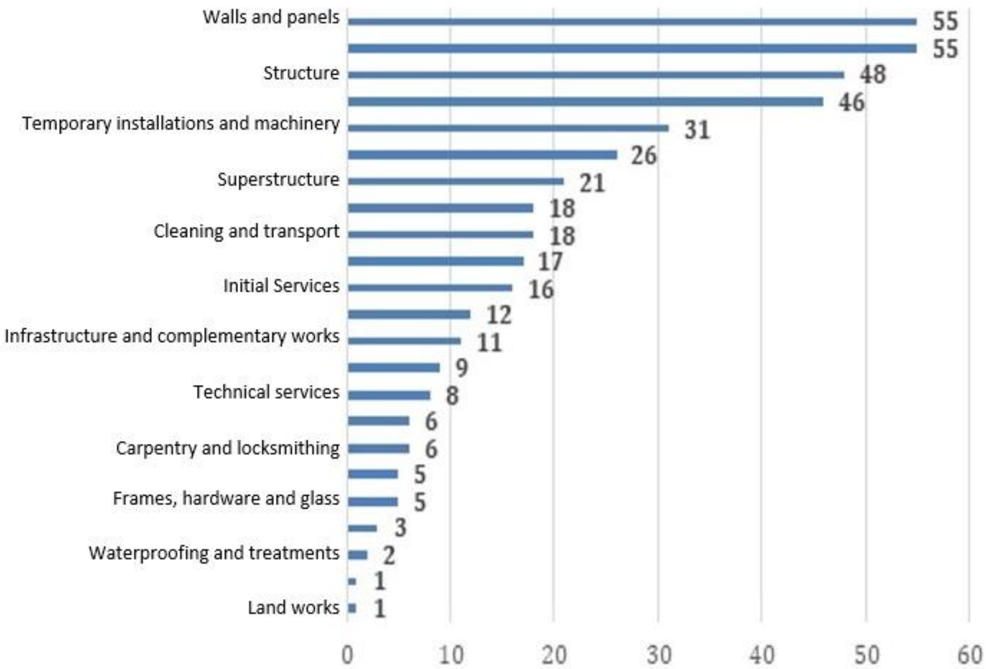

Figure 2: Different types of making-do waste analyzed by the activity stage (Figure 2 source: the authors)

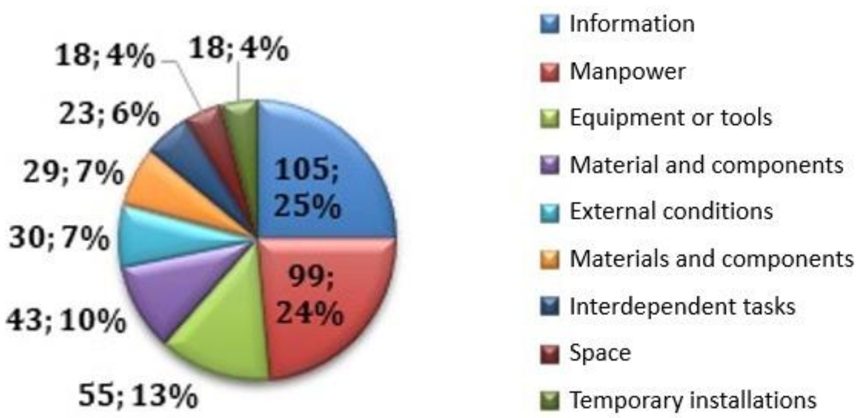

Figure 3: Occurrence of missing prerequisites for different kinds of making-do waste (Figure 3 source: the authors)

In the proposing guidelines stage, the aim was to evaluate all the information provided on the loss occurrence and consolidate all the results found to define the guidelines. These classifications supported the systematic analysis of the guidelines to act on the causes of the loss occurrences. After they were drawn up, the guidelines went through a validation process with a specialist in production management, who suggested improvements and clarified doubts by consulting the guidelines. Once the adjustments suggested by the specialist had been made, the guidelines were taken to a second validation stage, this time with the research group responsible for collecting and classifying the losses that make up the database used in this work. Four group members took part in a focal meeting for discussions and validation and suggested adjustments and improvements, which were carried out, and finally, the guidelines were validated. Thus, one or more guidelines capable of preventing the loss from occurring were proposed. In total, 47 guidelines were created, applied to 420 different types of waste, resulting in 916 propositions in the database. Table 4 presents five guidelines with the highest number of occurrences.

Table 4: Guidelines with the highest number of occurrences in the different types of waste analyzed (Table 4 source: the authors)

PROPOSED GUIDELINE	NUMBER OF OCCURRENCES	PERCENTAGE OF APPLICATIONS AMONG THE PROPOSITIONS
Carry out verification and inspection from FVS before, during, and after performing the service.	203	22.16%
Carry out periodic training of the workforce (monthly or bimonthly) according to the greatest needs and execution flaws, promoting qualification and generating social value for the enterprises.	124	13.54%
Make sure that the most updated and corrected version of the project is on-site, and that it has all the information necessary to carry out the service before starting its execution.	82	8.95%
Perform adequate protection of definitive items and finished services.	44	4.80%

It was observed that the same guideline could be applied to different stages of work to avoid a given loss due to making-do. Given the stages of work with the most significant occurrence of waste, Annex 1 shows an example of a guideline ready for each stage.

As a suggestion to implement the proposed guidelines, Figure 4 presents the application of the developed guidelines in the form of a workflow, that is, a flow of actions that will allow the use of these guidelines. This methodology involves its application from professionals on the service fronts to the management team, which can, in addition to constituting a mechanism for "attacking" the causes of making-do, contribute to forming a preventive and rationalized mentality that will permeate all hierarchical levels of companies.

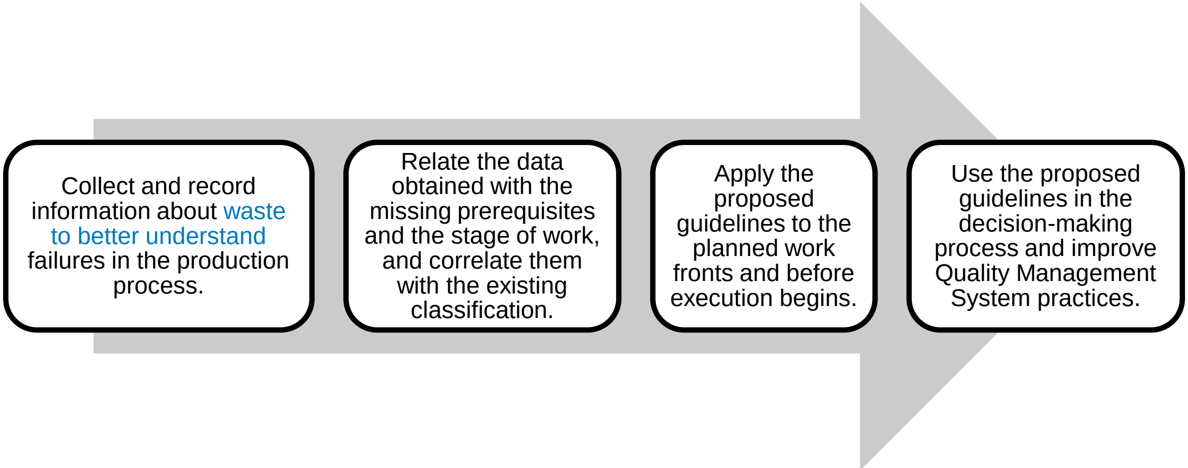

Figure 4: Workflow with a proposed methodology for applying the guidelines developed in this work (Figure 4 source: the authors)

The first step in implementing the proposed methodology involves collecting and recording detailed information about the waste identified during production. This data is essential for an in-depth understanding of the faults that can occur in the process itself. Next, it is necessary to relate the data obtained from the missing prerequisites and identify the specific stage of the construction where these occurred, correlating this information with the existing classification of the identified problems. Next, the obtained data needs to be correlated from the missing prerequisites and the specific stage of the work in which they occurred should be identified. This information is then correlated with the existing classification of the identified problems.

Once the data and correlations have been established, the proposed guidelines must be applied proactively on the planned work fronts before execution begins. This ensures that the recommendations are integrated into the process from the outset, facilitating identifying and preventing potential problems. In addition, the guidelines should be used as part of the decision-making process to improve Quality Management System practices.

CONCLUSION

The present work proposed to outline a methodology capable of preventing the occurrence of making-do waste . Based on data collected at various construction sites, guidelines were drawn up that, when applied, can become a strategic tool combined with production management increasingly free from waste and waste.

Guidelines were developed for 420 types of waste that occurred at the most diverse stages of the work and classified with the most varied missing prerequisites, categories, and impacts. As can be seen in Figure 3, 105 (25%) of the different types of waste with developed guidelines refer to those whose missing prerequisite was Information. The interpretation of this data shows the importance of not only the management team and the construction team having access to all necessary information to carry out each task. This access helps avoid rework, productivity reduction, incomplete tasks, as well as demotivation and other negative impacts (Sommer, 2010; Fireman, 2012).

The guideline with the highest number of occurrences was "Perform verification and inspection from the FVS before, during and after the execution of the service". This shows the scope that this action can have as the existence of a Management System Effective Quality Management, which includes the assertive application of Service Verification Sheets, permeates all stages of the work, and can eliminate a large amount of waste.

It can also be seen from Figure 2 that 55 (13%) of the types of waste for which guidelines were developed refer to waste that occurred in the Walls and Panels stage, which also highlights the importance of evaluating and applying guidelines in this stage of work. This can contribute to the reduction of inefficiencies or waste during this stage.

Finally, we proposed a methodology tailored to the everyday operations of Civil Construction, drawing from the established guidelines, which were initially validated by a specialist and subsequently by members of the research group responsible for compiling the database used in the present work. This proposed methodology is based on four steps: collecting and recording information about waste during the production process to better understand the failures; then relating this data to missing prerequisites and identifying the stage of the work where they occurred, correlating with the classification of problems; then applying the proposed guidelines before carrying out the work to prevent any type of waste. Finally, the guidelines should be used in the decision-making process to minimize the occurrence of production losses. All this sequencing should be used in the documentary systems of the Quality Management System.

However, it is essential to stress that the management team must also comprehensively analyze the limitations and advantages of the proposed guidelines within their company, recognizing the variation in levels of education, standardized practices and executive processes applied to the context involved. It is also crucial for managers to ensure that the guidelines' viability and effectiveness can be questioned in environments where building systems and procedures differ significantly. For example, adopting certain practices may face obstacles in places where the workforce is less specialized or where procedures are less comprehensive. Therefore, the management team must assess the need to adapt their proposals to local conditions and carefully consider the various factors that influence success.

REFERENCES

Amaral, T. G.; Brandão, C.; Elias, K.; Braga, P.B. Identification of wastes due to improvisation on construction sites. REEC - Electronic Journal of Civil Engineering, Goiânia, v. 15, no. 1, p. 245–260. DOI: 10.5216/ REEC. v15i1.54562. Available at: https://revistas.ufg.br/reec/article/view/54562. 2019.

Amaral, T. G.; Mendes, M.; Alvarenga, N.; Guidelines for minimizing wastes due to making-do. In: BRAZILIAN SYMPOSIUM ON CONSTRUCTION MANAGEMENT AND ECONOMICS, 12., 2021, Maceió. Anais[...] Porto Alegre: ANTAC, 2021. p.1-8. Available at: https://eventos.antac.org.br/index.php/sibragec/article/view/424 . 2021.

Amaral, T. G.; Braga, P. B., Vieira; S. V; Barros Neto, J. P. Relations Between Preconditions, Categories and Impacts of making-do Wastes. Proceedings of the 30th Annual Conference of the International Group for Lean Construction (IGLC30), 1111-1122. doi.org/10.24928/2022/0219. 2022.

Amaral, T. G. A.; Maciel, C. C. M.; Del Grosso Filho, R. R.; Pessoni, R. C. S., Paula, G. S.; Silva, S. V. S. (2023). Results of the causes and impacts of making-do wastes in production in Fortaleza, Ceará, Brazil. Proceedings of the 31st Annual Conference of the International Group for Lean Construction (IGLC31), 1395– 1406. https://doi.org/10.24928/2023/0250.

Aslam, M., Gao, Z., Smith, G. Exploring factors for implementing lean construction for rapid initial successes in construction. Journal of Cleaner Production, Volume 277, 2020, 123295, https://doi.org/10.1016/j.jclepro.2020.123295 . 2020.

Aziz, R. F; Hafez, S. M. Applying lean thinking in construction and performance improvements. Alexandria Engineering Journal. Volume 52, Issue 4. Pages 679-695, https://doi.org/10.1016/j.aej.2013.04.008 . 2013.

Braga, P. B.. Analysis of wastes due to making-do using dynamic spreadsheets. Goiânia, 2018. Course completion work (Graduation in Civil Engineering), Federal University of Goiás, Goiânia, 2018.

Fireman, M. C. T.. Proposal for an Integrated Production and Quality Control Method , with Emphasis at Measurement of Wastes by Making -Do and Rework . Dissertation (Master's in Civil Engineering) - Postgraduate Program in Civil Engineering , Federal University of Rio Grande do Sul, Porto Alegre, 2012.

Freitas, J. V.; Correia, B. Contextualization of the principles of lean construction: application of the lean philosophy of the Toyota production system in the construction industry in practical examples. Civil Engineering. 2018.

Hussin, J.; Abdul Ri, Memon, A. The way forward in sustainable construction: issues and challenges. International Journal of Advances in Applied Sciences (IJAAS). 2. 31-42. 10.11591/ ijaas.v 2i1.1321. 2013

Koskela, L. Application of the New Production Philosophy to Construction. Technical Report no. 72. Center for Integrated Facilities Engineering. Stanford University, 1992.

Koskela, L. An Exploration Towards a Production Theory and its Application to Construction. Thesis (Ph.D) –Technical Research Center of Finland, Espoo, 2000.

Koskela, L. Making-do – The Eighth Category of Waste. In: CONFERENCE OF THE INTERNATIONAL GROUP FOR LEAN CONSTRUCTION, 12, 2004.

Maciel, C. C. M.; Cavalcante, G. O.; Epifânio, M. Protocol for identification and analysis of wastes due to making-do. Goiânia, 2020. Course completion work (Graduation in Civil Engineering), Federal University of Goiás, Goiânia, 2020.

Ohno, T. Toyota Production System: Beyond large-scale production. Cambridge, Massachusetts, Productivity Press. 1988.

Santos, A.; Formoso, C. T.; Isatto, E., Lantelme, E. Intervention method for reducing wastes in construction: user manual. Porto Alegre, SEBRAE/RS. 1996.

Santos, D. G.. Process management model in civil construction to identify facilitating activities. Doctoral Thesis (Doctor in Production Engineering) – Federal University of Santa Catarina, Florianópolis, 2004.

Santos, P. R. R; Santos, D. G. Investigation of wastes due to unfinished work and its impact on the cycle time of construction processes. Environment Built, v. 17, no. 2, p. 39–52. 2017.

Small, E.; Al Hamouri, K.; Al Hamouri, H. Examination of Opportunities for Integration of Lean Principles in Construction in Dubai. Procedia Engineering, vol. 196, p. 616–621. 2017.

Sommer, L. Contributions to a method for identifying wastes due to improvisation on construction sites. Porto Alegre, 2010. 150 f. Dissertation (master's in engineering) – Postgraduate Program in Civil Engineering, Federal University of Rio Grande do Sul, Porto Alegre, 2010.

Yücenur, G. N; Kaan, Ş. Sequential swara and fuzzy vikor methods in elimination of waste and creation of lean construction processes. Journal of Building Engineering, Volume 44, 2021,103196. https://doi.org/10.1016/j.jobe.2021.103196 . 2021.