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REVERSE LOGISTICS OF CONSTRUCTION WASTE FOR THE DEMOLITION CONTRACTOR STAKEHOLDER: Validation of barriers for the Brazilian Context

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Introdução
Rose and Stegemann (2018) emphasize that waste management has been gaining prominence in the corporate arena, with reverse logistics (RL) serving as a strategy to reintroduce waste into the production cycle and mitigate environmental impacts. The construction sector is responsible for significant consumption—and consequent waste—of natural resources (Arora et al., 2021), and the role of demolition contractors is central to minimizing construction and demolition waste (C&DW).

Problema de Pesquisa e Objetivo
Implementing RL faces barriers as the complexity of demolition processes, which demand studies and planning (Rose & Stegemann, 2018). Arora et al. (2020) further contend that RL for construction waste is particularly relevant in Brazil, where rapid urban growth and the economic significance of construction call for sustainable practices. This study aims to identify and validate for Brazilian context, the barriers to RL of C&DW for the demolition-contractor stakeholder

Fundamentação Teórica
Among barriers are the lack of infrastructure,absence of economic incentives,technological challenges,and regulatory gaps.Barriers include:the absence of a market for recycled materials(Neto & Correia, 2019),lack of public policies(Mhatre et al., 2023),shortage of appropriate technologies and equipment,scarcity of recycling facilities (Narcis, Ray, & Hosein, 2019),the absence of standardized waste codes(Tangtinthai, Heidrich, & Manning, 2019),restricted areas for final disposal(Shi, Huang, & Xu, 2023), and the pressing need for government regulation and enforcement(Neto & Correia, 2019).

Metodologia
The methodology combines a bibliographic review and practical validation with relevant stakeholders.The analysis was conducted using the Lawshe method.15 barriers were identified and assessed through a Google Forms questionnaire with three response options:essential,important but not essential,and not important.The survey included demolition companies, engineers and environmental consultants, academics, government agencies, regulators, associations, and unions in the sector.Responses were analyzed using the Content Validity Ratio(Lawshe, 1975).

Análise e Discussão dos Resultados
15 barriers were identified in the literature.The barriers with a CVR above the critical were classified as validated,whereas those with lower values were not validated.In total, 11 barriers were validated.In the technical domain,the key barriers include:the absence of designs that facilitate deconstruction (Iacovidou & Purnell,2016),inadequate connection techniques(Chinda,2017),and poorly designed joints(Charef, Morel, & Rakhshan, 2021).These barriers demonstrate that overcoming them is crucial to enabling circular economy in the sector.

Considerações Finais
The contributions of the study are:a theoretical framework of 15 barriers identified in the literature;11 barriers validated within the Brazilian context,serving as a practical guide for companies;suggested actions to overcome these barriers;and qualitative correlations among them.Limitations include the study’s exclusive focus on Brazil, which restricts generalizability.Future research could employ other statistical analysis to deepen the understanding of barriers.The widespread adoption of RL for C&DW depends on investments and public policies that promote a circular economy in the sector.

Referências
ARORA, M. et al. Residential building material stocks and component-level circularity: The case of Singapore. Journal of Cleaner Production, v. 216, p. 239–248, 10 abr. 2019;LAWSHE, C. H. A quantitative approach to content validity”.Personnel Psychology, v. 28, p. 563–575, 1975;NARCIS, N.; RAY, I.; HOSEIN, G. Construction and demolition waste management actions and potential benefits: A perspective from Trinidad and Tobago. Buildings, v. 9, n. 6, 2019;ROSE, C. M.; STEGEMANN, J. A. From waste management to component management in the construction industry. Sustainability (Switzerland), v. 10, n

Palavras Chave
Desconstruction, Waste recovery, Construction and demolition waste

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REVERSE LOGISTICS OF CONSTRUCTION WASTE FOR THE DEMOLITION CONTRACTOR STAKEHOLDER: Validation of barriers for the Brazilian Context

1 INTRODUCTION

Rose and Stegemann (2018) emphasize that waste management has been gaining prominence in the corporate arena, with reverse logistics (RL) serving as a strategy to reintroduce waste into the production cycle and mitigate environmental impacts. The construction sector is responsible for significant consumption—and consequent waste—of natural resources (Arora et al., 2021), and the role of demolition contractors is central to minimizing construction and demolition waste (C&DW). However, implementing RL faces barriers, especially due to the complexity of demolition processes, which demand detailed studies and planning (Rose & Stegemann, 2018). Arora et al. (2020) further contend that RL for construction waste is particularly relevant in Brazil, where rapid urban growth and the economic significance of construction call for sustainable practices. Nevertheless, logistical and regulatory barriers (Charef, Morel, & Rakhshan, 2021) hinder its application. Accordingly, this study aims to identify and validate, within the Brazilian context, the barriers to RL of C&DW for the demolition-contractor stakeholder, thereby contributing to the advancement of the circular economy (CE) and sustainability in the sector.

2 THEORETICAL FOUNDATION

Among the identified barriers are the lack of infrastructure, absence of economic incentives, technological challenges, and regulatory gaps, which serve as a foundation for future strategies that promote the circular economy (CE) and sustainability.

The literature highlights technical obstacles: Iacovidou and Purnell (2016) note that current construction components hinder deconstruction, such as heavy concrete and steel bound to other materials; Chinda (2017) and Charef, Morel, and Rakhshan (2021) reinforce that inadequate connection techniques prevent the efficient separation of materials, thereby increasing costs and disposal; Arora et al. (2021) observe that such material bonds require skilled labor and preliminary studies for proper location; and Ding, Wang, and Chan (2023) associate the problem with the predominance of materials derived from the linear economy, which complicate tracking and reuse.

Measures such as detailed inventories (Rose & Stegemann, 2018; Arora et al., 2021) can enhance circularity by enabling the reuse of steel, concrete, windows, and doors. However, deconstruction is more costly and time-consuming than demolition, requiring four-stage planning (Kang et al., 2022) as well as proper waste management. The preference for the traditional demolition method stems from lower costs, shorter timeframes, and limited space for storing recovered materials (Rose & Stegemann, 2018).

Additional barriers include: the absence of a market for recycled materials in Brazil (Neto & Correia, 2019), lack of public policies (Mhatre et al., 2023), shortage of appropriate technologies and equipment, scarcity of recycling facilities (Narcis, Ray, & Hosein, 2019), the absence of standardized waste codes (Tangtinthai, Heidrich, & Manning, 2019), restricted areas for final disposal (Shi, Huang, & Xu, 2023), and the pressing need for government regulation and enforcement (Neto & Correia, 2019e). Thus, overcoming these barriers requires integration among government, the construction sector, and society to enable RL of construction and demolition waste, strengthening the CE and minimizing environmental impacts.

3 METHODOLOGY

The project, conducted between March and December 2024, aimed to identify and validate barriers to reverse logistics (RL) of construction and demolition waste (C&DW) for the Demolition Contractor stakeholder. It was developed in five stages: identification of barriers, development of the data collection instrument, selection of respondents, data collection, and analysis/discussion of results.

The barriers were initially identified from the project *"Proposal of a Reverse Channel for Construction and Demolition Waste to Reduce the Socio-Environmental Impacts of Irregular Disposal of this Waste in the Municipality of Belém-PA."* For the Demolition Contractor stakeholder, 15 barriers were identified and assessed through a Google Forms questionnaire with three response options: "essential," "important but not essential," and "not important." The survey included demolition companies, engineers and environmental consultants, academics, government agencies, regulators, associations, and unions in the sector. The study complied with the standards of the National Research Ethics Council, ensuring anonymity and exclusive use of the data for scientific purposes.

Responses were analyzed using the Content Validity Ratio (CVR) (Lawshe, 1975). Positive values indicated that more than 50% of respondents considered the barrier "essential," while negative values reflected the opposite. The critical CVR (CVRcritical) was calculated based on mean, variance, and standard deviation, following Silva (2016) and Rampasso (2020, 2021), and was used to exclude items below the established threshold.

4 ANALYSIS AND DISCUSSION OF THE RESULTS

The following Table 1 presents the integrative framework of all barriers identified in the literature review.

Table 1 - Summary of the identified barriers

Barriers	Descripton	Cod.
1 - Buildings and construction components not designed for deconstruction	The use of concrete and steel, combined with design limitations and the absence of joints, hinders deconstruction and reduces reuse potential.	1
2 - The techniques used to connect different materials are inadequate for deconstruction.	Connection techniques hinder separation during deconstruction, increasing costs and encouraging disposal in landfills.	2
3 - Difficulty in recovering construction components due to joints and connections.	Improper connections hinder recovery, requiring skilled labor and prior studies.	3; 4
4 - Existing building stock inherited from the linear economy.	Linear economy materials hinder tracking and lifecycle management of components.	5
5 - Lack of a component inventory.	The absence of a component inventory limits circularity and leads to the waste of natural resources.	4
6 - Need for time to analyze buildings scheduled for demolition.	Preliminary analysis of buildings is essential for sustainable demolition, but it requires significant time and resources.	7; 3; 6
7 - Preference for traditional demolition over the deconstruction process.	Companies prefer traditional demolition because it is faster and less costly, given the challenges associated with deconstruction.	7; 4
8 - Lack of technological knowledge regarding selective demolition.	Demolition technology faces challenges in identifying reusable materials, requiring greater investment.	8; 9
9 - Lack of procedures for utilizing materials obtained from selective demolition.	The absence of policies and planning hinders the incorporation of recycled materials into new constructions.	8; 10
10 - Inability to return C&DW components to their respective manufacturers.	The lack of a logistical system and tax incentives hinders the recycling and reuse of components.	5

11 - Lack of adequate vehicles and equipment to operate reverse logistics.	Inadequate vehicles and equipment increase costs and CO_2 emissions, requiring careful prior planning.	8
12 - Lack of facilities for material recycling.	The lack of recycling facilities hinders the reuse of construction and demolition materials.	11
13 - Lack of standardized waste classification codes.	The absence of standardized waste codes hinders the management and identification of material types.	12
14 - Lack of available land in cities to support the continuous disposal of C&DW in landfills.	Urban expansion reduces the availability of land for C&DW disposal.	13
15 - Lack of legislation related to selective demolition.	The absence of regulation and enforcement undermines reverse logistics, increasing waste generation and resource depletion.	8
References: 1 - Iacovidou e Purnel (2016); 2 - Chinda (2017); 3 - Charef, Morel e Rakhshan (2021); 4 - Arora et al. (2021); 5 - Ding, Wang e Chan (2023); 6 - Kang et al. (2022); 7 - Rose e Stegemann (2018); 8 - Neto, GCO; Correia, JMF (2019); 9 - Pun, Sung Kin; Liu, Chunlu; Langston, Craig; Treloar, Graham (2007); 10 - Mhatre, Purva; Gedam, Vidyadhar V.; Unnikrishnan, Seema; Raut, Rakesh D. (2023); 11 - Narcis, Nigel; Ray, Indrajit; Hosein, Gino (2019); 12 - Tangtinthai, Napaporn; Heidrich, Oliver; Manning, David A.C (2019); 13 - Shi, Yi; Huang, Yidan; Xu, Jiuping (2020)		

Fonte: Authors (2025).

4.1 DESCRIPTIVE ANALYSIS OF THE RESPONDENTS

The questionnaire was distributed to 143 potential participants, yielding 31 responses (21.67%) between October 9 and December 13, 2024. Three of the five targeted profiles participated: sustainability/waste management professionals, researchers, and demolition companies; however, associations, unions, and regulatory agencies did not respond.

Regionally, the Southeast, North, and South stood out—the Southeast due to the strength of its market and the North due to the author's direct contact with researchers. Regarding professional experience, 78.6% reported a medium level (5–15 years), 16.2% a high level (>15 years), and 6.5% a low level (<5 years), thereby ensuring the qualification of respondents. In terms of knowledge, 85.7% indicated experience with deconstruction and 82.1% with selective demolition, confirming technical alignment with the research topic.

4.2 ANALYSIS OF THE BARRIERS USING THE LAWSHE METHOD

After the participation of 31 respondents in the questionnaire, calculations of mean, variance, standard deviation, critical n, and critical CVR were performed. This value serves as the basis for validating the analyzed content, with the reference values presented in the table 2.

Table 2: Calculation of Parameters for the Lawshe Method

Parameters	Valors
Average	15,500
Variance	7,750
Standard Deviation	2,783
n critical	20,956
CVR critical	**0,352**

Fonte: Authors (2025)

Table 3 presents the identified barriers and their validation using the Lawshe method. All barriers with a CVR above the critical CVR (0.352) were classified as validated, whereas those with lower values were not considered essential by the respondents and, therefore, were not validated. In total, 11 barriers were validated. The non-validated barriers indicate that, although mentioned in the literature, they were not deemed a priority by the consulted experts.

Table 3: Validation of Barriers Using the Lawshe Method

CODE	REVIEWS: "ESSENTIAL"	CONTENT VALIDITY RATIO (CVR)	CVRCRITICAL: 0,352
B1	21	0,0354	VALIDADO
B2	23	0,4838	VALIDADO
B3	24	0,5483	VALIDADO
B4	15	-0,0322	NÃO VALIDADO
B5	14	-0,0967	NÃO VALIDADO
B6	27	0,7419	VALIDADO
B7	24	0,5483	VALIDADO
B8	24	0,5483	VALIDADO
B9	17	0,0967	NÃO VALIDADO
B10	21	0,3548	VALIDADO
B11	22	0,4193	VALIDADO
B12	22	0,4193	VALIDADO
B13	15	-0,0322	NÃO VALIDADO
B14	24	0,5483	VALIDADO
B15	24	0,5483	VALIDADO

Fonte: Authors (2025)

4.2.1 Discussion of the Barriers Validated by the Lawshe Method

Using the Lawshe method, 11 barriers to the implementation of reverse logistics (RL) for construction and demolition waste (C&DW) were identified and validated, aligning with the literature. In the technical domain, the key barriers include: the absence of designs that facilitate deconstruction (B1) (Iacovidou & Purnell, 2016), inadequate connection techniques (B2) (Chinda, 2017), and poorly designed joints (B3) (Charef, Morel, & Rakhshan, 2021). In the operational domain, the barriers highlighted are: the need for additional time to analyze the building (B6) (Kang et al., 2022), preference for traditional demolition without tax incentives (B7) (Arora et al., 2021), and lack of technical knowledge (B8) (Neto & Correia, 2019).

Regarding logistics and infrastructure, barriers include the absence of return systems (B10) (Ding, Wang, & Chan, 2023), lack of vehicles/equipment (B11) (Neto & Correia, 2019), absence of recycling facilities (B12) (Narcis, Ray, & Hosein, 2019), and limited land for safe disposal (B14) (Shi, Huang, & Xu, 2023).

In the legal domain, the main barrier is the absence of specific regulations (B15) (Neto & Correia, 2019). These technical, operational, logistical, and legal barriers demonstrate that overcoming them (through deconstruction-oriented design, reversible techniques, adequate infrastructure, return systems, tax incentives, and regulatory frameworks) is crucial to enabling circular economy practices and sustainability in the construction sector.

4.2.2 Discussion of the Barriers Not Validated by the Lawshe Method

Among the non-validated barriers, there was no consensus regarding their essentiality. Barrier B4 (stock inherited from the linear economy) reflects the low utilization of circular economy materials, although it remains relevant for RL of C&DW (Ding, Wang, & Chan, 2023). Barrier B5 (absence of a component inventory) hinders the reuse of steel, concrete, windows, and doors; while Arora et al. (2021) advocate its adoption, in Brazil—where conventional demolition predominates—it was not considered essential. Barrier B9 (lack of procedures for utilizing materials from selective demolition) is related to the absence of public policies (Mhatre et al., 2023); despite financial challenges highlighted by Neto & Correia (2019), it had a lower impact compared to other barriers. Finally, Barrier B13 (absence of standardized codes, such as CER) impairs efficient waste management (Tangtinthai, Heidrich,

& Manning, 2019), but in the Brazilian context, its implementation was perceived as having low immediate impact.

4.3 QUALITATIVE ANALYSIS OF CORRELATIONS AMONG THE BARRIERS

Barriers B1, B2, and B3 are interconnected, as they pertain to building design and the specification of materials and connections: designs that do not consider deconstruction (B1), the use of inadequate connection techniques (B2), and joints that hinder component recovery (B3), such as permanent welds, reduce the potential for material reuse. Barriers B6 and B7 are also related, since the time required for preliminary building analysis (B6) discourages deconstruction and reinforces the preference for traditional demolition (B7), which is faster and less technically demanding. Finally, B15—the absence of specific legislation—has a transversal impact on all other barriers: it limits design for deconstruction (B1, B2, B3), hampers reverse logistics (B10, B11, B12), and sustains the preference for traditional demolition (B6, B7) by failing to provide clear guidelines or incentives for sustainable practices.

5 FINAL CONSIDERATIONS

The study validated 11 barriers to the implementation of reverse logistics (RL) for construction and demolition waste (C&DW) in Brazil, according to professionals in the field. Despite widespread knowledge of deconstruction (85.7%) and selective demolition (82.1%), obstacles persist, including inadequate building structures, difficulties in material recovery, lack of equipment and facilities, and the absence of specific legislation.

Validation using the Lawshe method underscores the complexity of the topic and the need for coordinated actions among companies, governments, and research institutions. The contributions of the study include: (i) a theoretical framework of 15 barriers identified in the literature; (ii) the 11 barriers validated within the Brazilian context, serving as a practical guide for companies; (iii) suggested actions to overcome these barriers; and (iv) qualitative correlations among them. Limitations include the low response rate and the study's exclusive focus on Brazil, which restricts generalizability. Future research could employ cluster analysis, TOPSIS, and multivariate analysis to deepen the understanding of these barriers. In conclusion, although conceptual knowledge exists, the widespread adoption of RL for C&DW depends on investments in technology, training, and public policies that promote a circular economy in the construction sector.

6 REFERENCES

ARORA, M. et al. *Residential building material stocks and component-level circularity: The case of Singapore.* ***Journal of Cleaner Production***, v. 216, p. 239–248, 10 abr. 2019.

ARORA, M. *Urban mining in buildings for a circular economy: Planning, process and feasibility prospects. Resources****, Conservation and Recycling***, v. 174, 1 nov. 2021.

CHAREF, R.; MOREL, J. C.; RAKHSHAN, K. ***Barriers to implementing the circular economy in the construction industry: A critical review***. ***Sustainability (Switzerland)***. [S.l.]: MDPI. , 1 dez. 2021

CHINDA, T. ***Examination of Factors Influencing the Successful Implementation of Reverse Logistics in the Construction Industry: Pilot Study.*** 2017, [S.l.]: Elsevier Ltd, 2017. p. 99–105.

DING, L.; WANG, T.; CHAN, P. W. ***Forward and reverse logistics for circular economy in construction: A systematic literature review***. ***Journal of Cleaner Production***. [S.l.]: Elsevier Ltd. , 15 fev. 2023

IACOVIDOU, E.; PURNELL, P. *Mining the physical infrastructure: Opportunities, barriers and interventions in promoting structural components reuse.* ***Science of The Total Environment***, v. 557–558, p. 791–807, 2016. Disponível em: <https://www.sciencedirect.com/science/article/pii/S0048969716305228>.

KANG, K. et al. *Building demolition waste management through smart BIM: A case study in Hong Kong.* ***Waste Management***, v. 143, p. 69–83, 15 abr. 2022.

LAWSHE, C. H. *A quantitative approach to content validity".Personnel Psychology.* ***Personnel Psychology***, v. 28, p. 563–575, 1975.

LUZ, B. (Org.). **Economia circular Holanda: Brasil: da teoria à prática**. 1. ed. -- Rio de Janeiro: Exchange 4 Change Brasil, 2017.

MHATRE, P. et al. *Circular economy adoption barriers in built environment- a case of emerging economy.* ***Journal of Cleaner Production***, v. 392, p. 136201, 2023. Disponível em: <https://www.sciencedirect.com/science/article/pii/S0959652623003591>.

NARCIS, N.; RAY, I.; HOSEIN, G. *Construction and demolition waste management actions and potential benefits: A perspective from Trinidad and Tobago.* ***Buildings***, v. 9, n. 6, 2019.

OLIVEIRA NETO, G. C.; CORREIA, J. M. F. *Environmental and economic advantages of adopting reverse logistics for recycling construction and demolition waste: A case study of Brazilian construction and recycling companies.* ***Waste Management & Research***, v. 37, n. 2, p. 176–185, 11 jan. 2019. Disponível em: <https://doi.org/10.1177/0734242X18816790>.

PUN, S. K. et al. *Electronic Waste Exchange for Just-in-Time Building Demolition.* ***International Journal of Construction Management***, v. 7, n. 2, p. 65–77, 1 jan. 2007. Disponível em: <https://doi.org/10.1080/15623599.2007.10773103>.

ROSE, C. M.; STEGEMANN, J. A. *From waste management to component management in the construction industry.* ***Sustainability (Switzerland),*** v. 10, n. 1, 17 jan. 2018.

SHI, Y.; HUANG, Y.; XU, J. *Technological paradigm-based construction and demolition waste supply chain optimization with carbon policy.* ***Journal of Cleaner Production***, v. 277, p. 123331, 2020. Disponível em: <https://www.sciencedirect.com/science/article/pii/S095965262033376X>.

TANGTINTHAI, N.; HEIDRICH, O.; MANNING, D. A. C. *Role of policy in managing mined resources for construction in Europe and emerging economies.* ***Journal of Environmental Management***, v. 236, p. 613–621, 2019. Disponível em: <https://www.sciencedirect.com/science/article/pii/S0301479718314063>.