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SUSTAINABILITY AND CENTRALITY OF CEMENT: Analysis of Purchasing Practices in Maranhão's Civil Construction Sector

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ABSTRACT
This article investigates the effects of environmental sustainability on cement purchasing decisions by construction companies in the state of Maranhão, Brazil. Considering the growing debate on sustainable practices in the industrial sector, the study seeks to analyze how the adoption of environmental technologies—such as waste co-processing and energy cogeneration—influences the perceived value of cement in the selection of materials for construction projects. The research adopts Centrality Theory as its theoretical framework, addressing the importance of key attributes in concept formation and applying it to the perception of cement as an essential construction material. A qualitative, exploratory, and descriptive methodology was employed, based on semi-structured interviews with engineers working in Maranhão-based construction companies. The results indicate that environmental sustainability is recognized as a positive differentiator, without compromising the image of strength and durability associated with cement. However, there is a need for greater dissemination of information about sustainable practices adopted by cement industries in order to strengthen the market's environmental awareness. The study contributes to understanding new demands for environmental responsibility in civil construction and provides guidance for communication strategies within the cement sector.
Keywords: *Environmental sustainability. Cement industry. Purchasing decision. Civil construction. Maranhão.*

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I. INTRODUCTION

The civil construction industry in Brazil recorded an average annual growth rate of 2.3% between 2010 and 2020 (CBIC, 2021), influenced by the expansion of housing programs such as Minha Casa Minha Vida, investments in infrastructure, and increased availability of real estate credit. Due to Brazil's housing deficit, policies promoting sustainable urban planning and development have been encouraged through the construction of housing projects with sustainable and more affordable parameters (CBIC, 2022).

The construction sector is characterized by its heterogeneity, as it comprises a complex production chain (MELLO; AMORIM, 2009), generates employment, income, and taxes (CBIC, 2022), and stimulates various economic sectors, among which cement and concrete, mineral extraction, machinery and equipment, and steel products stand out.

The cement industry, the focus of this study, generates environmental impacts due to the large-scale extraction of natural resources and the emission of greenhouse gases. According to the Brazilian Portland Cement Association (ABCP, 2023), cement production processes are highly energy-intensive operations, accounting for about 30% to 40% of total production costs. The cement industry is one of the largest CO_2 emitters in the global manufacturing sector (GCCA, 2023).

Brazil is currently the seventh largest cement producer in the world (SNIC, 2023), with an output of approximately 64 million tons in 2023. According to the National Cement Industry Union (SNIC, 2023), about 95% of the cement produced in the country is consumed by the civil construction sector. The Northeast region accounts for about 16% of national consumption, and the state of Maranhão has stood out due to increased demand related to infrastructure works, housing, and renewable energy projects.

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Energy consumption in the cement industry tends to rise, driven by increased urbanization and public works, while at the same time, the pressure to reduce environmental impacts is also intensifying. Thus, industries have been seeking mechanisms to mitigate their impacts, notably the adoption of industrial waste co-processing and energy cogeneration (ABCP, 2023).

However, stakeholder involvement is necessary for the environmental repositioning of the cement industry, through the use of sustainable practices and green marketing, which integrates transformative changes capable of creating value for individuals, society, and the natural environment (POLONSKY, 2011).

Given that consumer discourse—including in the corporate market—reflects a growing concern for social and environmental responsibility, questions arise as to what factors determine the extent to which cement is perceived as a "green" product and how its sustainable attributes impact purchasing decisions (GERSHOFF; FRELS, 2015).

According to Centrality Theory, conceptual characteristics differ in how they are mentally represented. Central attributes are more immutable and more influential in the categorization of objects (SLOMAN, LOVE; AHN, 1998).

In this regard, this research proposes to associate Centrality Theory with cement, assuming that the strength/durability attribute—central to the representation of cement—may or may not be influenced by the introduction of sustainable practices in its production.

In this context, the guiding question of the study is: does the environmental sustainability of cement, as a central attribute of construction, compromise its image of strength among buyers? To answer this question, the objective of the article is to assess the perception of the centrality of cement among engineers working in the civil construction sector in the state of Maranhão.

In addition to the introduction, this article comprises four further sections. The second section presents the theoretical background; the third describes the methodological procedures; the fourth discusses the results obtained; and the fifth presents the final considerations.

II. LITERATURE REVIEW

2.1 Centrality Theory

Centrality Theory relates to cognitive studies that seek to understand the mental processing of stimuli to generate internal representations adapted to reality (SILVA et al., 2010). These mental representations function as internal models that guide individuals' cognitive actions, being composed of symbols, images, and ideas that help in interpreting the real world (VASCONCELLOS; OLIVEIRA, 2012).

Silva et al. (2010) explain that representation has two meanings: the first refers to the construction of a mental map, as a reflection of the perceived reality phenomenon; the second considers representation as the foundation of knowledge, allowing the individual to retrieve pre-existing concepts and assign new meanings. According to Okada and Santos (2005), mental maps are graphically organized to trace the thought process and articulate new ideas.

In cognitive studies, it is common to use models that assume that mental representations can be broken down into sets of attributes, which vary in centrality. The centrality of a feature is understood as the degree to which it is essential to the definition of a concept. Thus, concepts differ regarding the centrality of their attributes, influencing how they are perceived and categorized (SLOMAN; LOVE; AHN, 1998; BARSALOU, 2020).

Given the absence of a model that precisely addressed centrality within an intuitive theory of concepts, Sloman, Love, and Ahn (1998) proposed an approach that connects the internal conceptual structural view to categorization behavior, considering the dependence of attributes. In this model, the immutability of an attribute represents its resistance to transformation within the conceptual structure.

For the authors, the centrality of an attribute is determined by its integration into the representation of the concept, with central attributes being those whose alteration would compromise the identity of the object. More recent research, such as Murphy (2022), indicates that central attributes can be reinterpreted without necessarily losing their conceptual status, especially when influenced by new social demands, such as environmental sustainability.

According to Sloman, Love, and Ahn (1998), it is important to distinguish between mutability, centrality, diagnosis, and relevance of a characteristic. While mutability relates to the individual's willingness to accept changes in the attributes of a concept, diagnosis refers to an attribute's ability to correctly indicate which category an object belongs to. Relevance, in turn, concerns the importance of an attribute in defining the category.

The concept is the mental representation that characterizes a category of objects. The internal perspective of the concept analyzes its internal structure—its essential characteristics—while the external perspective examines how specific instances fit into that category. In recent studies, Medin and Atran (2021) argue that cultural and environmental factors can influence the perception of attribute centrality, which is particularly relevant in the context of sustainable products, such as cement produced with ecological practices.

Additionally, the term diagnosis may refer to the informational value of an attribute across various categories or to its inferential power within a conceptual structure. While inferential power is built from relationships between attributes, mutability is associated with structural dependency relationships. In parallel, salience is understood as the perceptible intensity of an attribute, which stands out regardless of context, acting as a strong signal against background noise (SLOMAN; LOVE; AHN, 1998; ROSCH, 2020).

Applying these concepts to sustainability in the cement industry, it is possible to consider that strength, resistance, and durability of cement constitute central attributes in the perception of civil construction professionals. The introduction of environmental practices, such as co-processing and cogeneration, by modifying the perceived attributes of cement, raises questions about whether these practices affect central attributes or remain as peripheral additions, without altering the fundamental identity of the material in the minds of corporate consumers.

2.2 Purchasing Decisions in the Business Sector and Environmental Sustainability

The purchasing decision process in the business environment, especially in the civil construction sector, involves a series of technical, economic, and environmental factors. Unlike individual consumer decisions, purchases made by companies are generally more rational, based on performance, durability, cost-benefit, and alignment with the organization's strategic guidelines (SOUZA; CERVI; BRANCO, 2013).

With the increasing appreciation of social and environmental practices, environmental sustainability has become a relevant factor in the decision to purchase construction materials, including cement. According to Kotler (2022), organizations have been incorporating principles of sustainable marketing, considering not only economic value but also the social and environmental impacts of the products and services acquired.

The business decision to acquire sustainable materials, such as ecological cement, is related to building corporate image, complying with legal requirements, and responding strategically to pressure from stakeholders and end consumers (PEATTIE; BELZ, 2010). Practices such as waste co-processing and energy cogeneration, implemented in the cement industry, reinforce the environmentally responsible positioning of supplying companies.

According to Sheth and Parvatiyar (2020), sustainability influences the assessment of the central attributes of products. In the case of cement, strength and durability remain the main attributes considered in purchasing decisions, but there is a growing appreciation for production practices that minimize environmental impacts.

This paradigm shift impacts the decision-making structure in Maranhão's civil construction companies, where competitiveness and compliance with sustainable standards are increasingly required in public tenders, environmental certifications, and commercial relationships. Thus, analyzing the centrality of sustainable attributes in the cement selection process becomes fundamental to understanding the new purchasing dynamics in the sector.

2.3 Sustainability and Marketing in the Business Sector

Sustainability practices have been consolidating as central strategies for competitive differentiation and market positioning in organizations (KOTLER, 2022). In the business environment, the adoption of environmental, social, and governance (ESG) principles goes beyond mere compliance with legal standards, becoming a driver of perceived value for customers, investors, and strategic partners alike. In the civil construction industry, the pursuit of more sustainable materials, such as cement produced through waste co-processing or with lower CO_2 emissions, highlights this trend.

Corporate sustainability involves incorporating environmental and social concerns into the organization's daily operations and long-term strategies (PEATTIE; BELZ, 2010). In this context, sustainable marketing plays a fundamental role in articulating the communication of green product attributes, reinforcing the perception of responsibility and innovation in the market. According to Peattie and Crane (2005), green marketing should not only promote environmental benefits but also ensure that these benefits are genuinely perceived and integrated into the value proposition.

In the cement sector, the practice of sustainability has materialized through processes such as waste co-processing, the use of alternative fuels, and investment in energy cogeneration technologies (ABCP, 2023). These practices not only reduce the environmental impact of production but also create marketing narratives capable of strengthening brand image in the construction market.

According to Sheth and Parvatiyar (2020), corporate consumers are increasingly attentive to the environmental credentials of their suppliers, incorporating sustainability criteria into their purchasing decisions. In the context of Maranhão, where infrastructure, housing, and renewable energy projects have expanded, the adoption of sustainable materials has become not only a technical requirement but also one of reputation and competitiveness in the market.

Thus, understanding how attributes related to sustainability are incorporated into the assessment of essential products such as cement is crucial for organizations seeking strategic market positioning. Sustainable

marketing therefore emerges as a tool that bridges environmental innovation and perceived value, reinforcing the centrality of ecological attributes in contemporary business decisions.

2.3.1 Sustainable Marketing and Purchasing Decisions

Sustainable marketing is understood as a set of strategies and practices that promote products and services in ways that meet the needs of consumers and the market while preserving or improving environmental, social, and economic well-being (KOTLER, 2022). In the business environment, sustainability is becoming a decisive criterion not only for regulatory compliance but also for adding value to brands and strengthening competitiveness in highly demanding sectors such as civil construction.

According to Peattie and Belz (2010), sustainable marketing is not limited to publicizing environmental benefits but seeks to integrate the principles of sustainability throughout the product's value chain, from conception to post-consumption. In the cement sector, initiatives such as waste co-processing, reducing CO_2 emissions, and the use of biomass as a source of renewable energy illustrate sustainability practices that can be strategically communicated to the business market.

Thus, purchasing decisions in the corporate market increasingly incorporate sustainable attributes as relevant evaluation criteria. As Sheth and Parvatiyar (2020) point out, there is a growing tendency for buying companies to consider factors such as the carbon footprint of acquired materials, the life cycle of products, and the environmental impact associated with production. This evolution is particularly significant in Maranhão, where public policies to encourage sustainability and the increasing demand for environmental certifications reinforce the preference for construction materials with "green" attributes.

However, for sustainable attributes to effectively become competitive advantages, it is necessary for cement companies' marketing to be able to clearly and reliably communicate the environmental benefits of their products. In this sense, sustainable marketing should focus not only on the technical aspects of ecological processes but also on creating narratives that reinforce trust, innovation, and the brand's environmental commitment to its strategic audiences (PEATTIE; CRANE, 2005).

2.3.2 Perceived Value and Sustainability in Business Decisions

The concept of perceived value is fundamental to the analysis of business purchasing behavior, especially in industrial sectors that seek to balance technical performance with socio-environmental responsibility. Perceived value refers to the customer's subjective assessment of the benefits obtained in relation to the costs involved in acquiring a product or service (ZEITHAML, 1988). In the current context, attributes related to environmental sustainability have come to form part of the set of benefits considered in organizations' value perceptions (KOTLER, 2022).

According to Woodruff (1997), value is built on prior preferences and experiences, being influenced by tangible attributes such as quality and durability, and intangible ones such as corporate image and environmental responsibility. In the cement industry, practices such as waste co-processing and reduction of CO_2 emissions strengthen intangible attributes that positively impact the perception of value among institutional clients.

Recently, studies such as those by Sheth and Parvatiyar (2020) indicate that purchasing organizations have valued not only the technical attributes of materials but also their contribution to environmental goals, such as reducing the carbon footprint and promoting more sustainable construction. This trend is driven by public policies, environmental certifications, and stakeholder demands that favor suppliers aligned with ESG practices.

In Maranhão, where there is significant expansion of infrastructure and urbanization projects, the choice of sustainable materials becomes a strategic competitive advantage. Thus, understanding how sustainable attributes add perceived value to cement is essential for the local cement industry, which seeks to reposition itself in an increasingly demanding market in terms of environmental responsibility and innovation.

III. METHODOLOGY

This study is characterized as applied research, with both quantitative and qualitative approaches, and exploratory-descriptive objectives. Applied research aims to generate knowledge for practical application, seeking to solve specific problems in the cement sector in Maranhão related to value perception and business purchasing decisions regarding sustainable products. The mixed approach allows for both the description of behavioral patterns and the interpretation of perceptions held by engineers and managers working in the civil construction sector (GIL, 2019).

The research strategy adopted was a survey, through the application of semi-structured questionnaires. This procedure was chosen for its ability to systematically collect information directly from participants, allowing for a quantitative analysis of trends and perceptions as well as a qualitative exploration of opinions on sustainable practices in the cement market. Data collection was carried out with engineers and purchasing professionals from construction companies established in the state of Maranhão, specifically in cities with a high rate of infrastructure and housing projects, such as São Luís, Imperatriz, and Balsas.

The questionnaire was divided into three main blocks: the first aimed at respondent characterization (position, years of experience, area of expertise); the second addressed the importance of traditional cement attributes (strength, durability, resistance); and the third analyzed the perception of attributes related to environmental sustainability, such as waste co-processing, carbon emission reduction, and environmental certifications associated with cement production.

Participants were selected by non-probabilistic, intentional sampling, considering professionals working in medium and large companies who, in their practice, make or influence decisions on the acquisition of inputs for construction projects. The sample consisted of 50 respondents, a number considered appropriate for an exploratory study seeking to identify preliminary patterns of perception in the Maranhão market.

Quantitative data analysis was performed using descriptive statistics (frequencies, means, and standard deviation) and correlation analysis to verify associations between sustainable attributes and traditional attributes of strength and durability. For the qualitative analysis of open-ended responses, the content analysis technique proposed by Bardin (2016) was used, categorizing the responses into central themes related to value perception, sustainability, and innovation in the cement sector.

IV. PRESENTATION AND ANALYSIS OF RESULTS

4.1 Centrality Theory

The aim was to relate Centrality Theory to the perception of cement by identifying manifest or latent attributes in the categories of concept, diagnosis, and salience. The analysis focused on comparing traditional cement and so-called green cement, produced from sustainable practices such as the co-processing of industrial waste.

Initially, research subjects were prompted to generate spontaneous responses about their mental representations of ordinary cement and sustainable cement, using the technique of constructing mental maps to articulate concepts and new ideas (OKADA; SANTOS, 2005; SILVA et al., 2010). This approach enabled the capture of intuitive perceptions about the central and peripheral attributes associated with each type of cement.

Participants were also asked about the possibility of not using cement in construction works. Among the interviewees, E4 and E7 acknowledged this possibility, noting that "today we already have technology, and there has been technology for many years for construction without cement" (E4). However, interviewee E7 reflected: "I can imagine a construction without using cement, I just can't imagine a feasible construction in Brazil yet."

On the other hand, interviewees E2, E3, E4, E5, and E6 stated they could not conceive of the total absence of cement in construction, although they admit the possibility of reducing the volume used. This perception shows that, even with the emergence of sustainable alternatives, cement is still considered a central and virtually irreplaceable element in the conception of buildings in the Maranhão market.

"[...] I don't believe in construction totally without cement, but I'm certain it could be used in much smaller quantities." (E2)
"[...] There are technologies that significantly reduce cement consumption in superstructures, but at some stage of construction I can't imagine a project without it entirely." (E3)
"[...] I can't imagine a building without cement, but I can imagine one with less cement, or with another material replacing cement." (E5)
"Honestly, no. I imagine the introduction of new materials that increase the durability and quality of what we use today." (E6)

When asked about the possibility of using cement produced with waste from other industries—the so-called green cement—in civil construction projects, only interviewee E7 expressed difficulty in visualizing its practical application. For this interviewee, the idea of incorporating waste into the cement manufacturing process still raises uncertainties regarding the quality and market acceptance of the material.

In contrast, interviewees E2, E4, E5, and E6 acknowledged the feasibility of using green cement, although they expressed concerns related to economic, structural, and cultural factors. Among the issues raised were the resistance from the traditional industry (the lobbying of major cement companies), the possible increase in the price of sustainable cement, and the cultural and institutional barriers to the adoption of new materials in civil construction.

Such concerns were made explicit in the statements of the interviewees, indicating that although there is an initial willingness to accept green cement, factors external to the product—such as economic interests, market structure, and cultural standards—still represent significant obstacles to its full integration into the Maranhão market.

"I imagine so, [...] but there is very strong lobbying by cement companies. With the level of technology we have, I think this would be the simplest thing in the world. Now, it's hard to imagine this happening in a very short

period of time. Why? Precisely because the cement companies will do everything possible to prevent it from happening." (E2)

"I think this would be the solution to many problems, but safety must be ensured [...] It has to be approved by the competent authorities, but it would maintain a reverse policy of using materials from civil construction. We are a hub for generating waste, and I believe this would also help with the recycling that is so necessary for the construction industry." (E4)

"I believe so, as long as it has the same results and characteristics as regular cement, there won't be a problem. Of course, a new product needs to be cheaper, right? [...]. I believe this type of cement already exists, as I read a study about it three or four years ago, outside of Brazil, but it needs to be more affordable to be attractive. If it's more expensive, it becomes unfeasible, unless mandated by law, as is the case with wood." (E5)

"I can imagine it. The world is going through a cultural change, becoming more careful with the materials we extract from nature. One way to reduce these impacts is to introduce into new processes materials that have already been used. I observed that this process is already beginning in cement production, during a visit to a factory in Paraíba, where inert material is used in the manufacturing process." (E6)

The analysis of the interviewees' statements revealed that the mutability of the central characteristics of the cement concept is low among interviewees E2, E3, E5, and E6. These participants indicated that they cannot conceive of a project or construction without the use of cement, although they admit the possibility of reducing the amount used. This stance reinforces the idea that attributes such as strength, durability, and resistance remain central to the definition of cement, preserving the material's conceptual coherence even in the face of sustainable practices.

Regarding the category, the interviewees were prompted to reflect on the external perspective of the concept, considering new characteristics that could be incorporated into its structure without losing its identity. In particular, the study sought to understand whether alternative mixtures, developed from the addition of waste from other industries, would still be recognized as cement by professionals.

When asked about this possibility, all the interviewees agreed that these mixtures could indeed be called cement, provided that fundamental requirements such as technical standards, quality assurance, economic feasibility, and cultural acceptance are met. These conditions were pointed out as essential to ensure that sustainable innovation maintains the identity of cement and is effectively incorporated into civil construction practices in Maranhão.

"In reality, morphologically, cement contains binders, which are made from calcareous substances. But if we look at it, the term 'cement' is used in dentistry, as something that is pasty and, when you use it in greater proportion, it solidifies—let's say it petrifies in such a way as to be harder to break [...]? So actually, this mixture would be called cement [...] nowadays the term 'cement' is used for a material that has the power to solidify and bind things together." (E2)

"I believe so, if it is standardized." (E3)

"I believe the quality of cement, even by standards, must include a certain amount of pozzolana among other materials—even slag. So I believe that, depending on the type of waste and provided it does not compromise the quality of the cement, waste from other industries can indeed be used." (E4)

"Of course. This is mostly cultural; it's like having wooden or polyethylene molds—they're both molds, aren't they? [...] It would still be considered cement in the same way." (E5)

"We can't afford to think that we are the only ones with this process in the world; we have to analyze as many possibilities of other existing processes as possible, aiming for better quality and reduced costs in our production processes. Regardless of the additions and their origin, the concept of cement will not be changed because of this." (E6)

"If it had the same characteristics as conventional cement, I would consider it good cement." (E7)

When asked about previous experience with projects that used green cement in their structure, only interviewee E6 reported having managed a project with this type of material, stating: "Yes. I have already used CP II E to reduce the heat of hydration in foundations." The other interviewees said they had never been involved in projects that used green cement, and interviewee E7 stated that he was completely unaware of the existence of this product: "No, I have never been involved in any project using this cement and, in fact, I had never even heard of it."

Given this scenario, it can be inferred that, although the interviewees show a positive attitude toward the idea of green cement, this acceptance is conditional upon compliance with technical standards, quality assurance, and maintenance of the material's binding function. The conceptual and categorical structure of cement appears to be compatible with sustainable innovations; however, the actual behavior of purchasing and adopting such cement has not yet materialized for most professionals, as pointed out by Sloman, Love, and Ahn (1998).

With regard to the diagnosis, the aim was to identify inferential characteristics of green cement. When asked about the ideal percentage of waste to be incorporated into the product to characterize it as sustainable, interviewees E3 and E4 indicated a range of 6% to 20% added, a percentage compatible with NBR 11578, which regulates CPII-E cement (with 6% to 34% blast furnace slag). Interviewees E2 and E7 preferred not to comment, claiming a lack of technical knowledge on the subject. Interviewee E6 emphasized that, as long as it is properly standardized, recycled material would not compromise the quality of the cement, while interviewee E5 pointed out that the ideal proportion would depend on maintaining the mechanical properties, regardless of the amount of waste incorporated.

Regarding salience, it was not possible to identify a characteristic that stood out intensely and unequivocally. However, a signal/noise relationship was observed in the interviewees' perceptions, as only participant E5 stated prior knowledge of sustainable cement—although not under the term "green cement," but rather as "ecological cement," indicating a variation in the terminology used in the market.

"I only know about it from reading, as I said, not as green cement, but as ecological cement. I don't know if it's the same because I am unfamiliar with the term 'green cement.' The terminology I've heard is 'ecological cement' or cement that uses waste from other industries, but not as 'green cement.'" (E5)

It is assumed that, in the cement market, there is still little explicit disclosure about the concept of "green cement." Although some industries already incorporate waste from other productive activities into their cement composition, this practice does not appear to be strongly associated, from a marketing perspective, with the image of a "sustainable product." This finding suggests a gap in the communication of environmental attributes, which could be leveraged to add perceived value to these products.

In order to identify whether the use of green cement would compromise the perception of strength and durability in construction projects, the interviewees were asked about their confidence in these materials. Interviewee E3 expressed some mistrust, stating: "Until it is proven that ecological cement has the same strength, I don't trust it. So I want to see proof, experiments, tests to be able to verify that." This response indicates the need for technical support and empirical evidence so that new attributes are fully accepted in the market.

On the other hand, the other interviewees expressed confidence that the durability and strength of structures would not be compromised by the use of green cement, provided the product meets current technical standards. This perception reinforces the hypothesis that, for most professionals, the central attribute of strength remains intact, even with the introduction of sustainable practices in cement production.

4.2 Environmental Sustainability

In this study, in addition to analysis through the lens of Centrality Theory, an effort was made to correlate the interviewees' perceptions with the context of business relations, emphasizing the importance of environmental sustainability as a criterion in the decision to purchase construction materials. Participants were asked about the influence of sustainability on the credibility of projects, their knowledge of technologies such as waste co-processing and energy cogeneration, and the effectiveness of supplier communication regarding their sustainable practices and product portfolios.

The business market in civil construction is made up of organizations that acquire goods and services used in the production of projects intended for sale, leasing, or service provision. Business-to-business purchases tend to involve larger volumes, more technical negotiations, and multiple evaluation criteria, making them significantly different from end-consumer purchasing behavior (KOTLER; KELLER, 2022).

When asked whether environmental sustainability affects the credibility of a project or construction, interviewees E2 to E7 were unanimous in stating that it does. They emphasized that environmental responsibility has already become an essential factor for building a positive image, both in public and private projects. They also highlighted the need for greater awareness on the part of construction companies and suppliers, so that sustainability is integrated not only as a formal requirement but as an intrinsic value in projects and construction processes.

"Without a doubt, sustainability affects the credibility of the project, absolutely." (E2)
"[...] Sustainability is used as marketing for selling apartments, using renewable energy and other ways to show clients that the construction company cares about the environment. I believe this could even be a selling point in this time of crisis." (E3)
"I don't see it as affecting; I see it as greater sustainability in terms of feeling assured that we're doing our part and contributing to a better world, right? That we have the technology and capability to really use recyclable materials or other technologies." (E4)

"[...] People still need to become more aware, and the environmental issue in Brazil is still very misunderstood. The credibility due to environmental sustainability is still viewed in a mistaken way here in Brazil, you know? We don't have the awareness or evolved thinking to understand this environmental issue here yet." (E5)
"All commercial activities are regulated by consumer needs. Today we are experiencing a cultural change where the green seal is a market differentiator, and I believe that in the future it should become a construction requirement. The new 2017 São Paulo Code of Works and Buildings has numerous mandatory sustainable guidelines, which will be a step toward standardizing this across Brazil." (E6)
"Sustainability today greatly affects the credibility of a project." (E7)

With regard to prior knowledge about co-processing, all interviewees, except for interviewee E5, reported not being familiar with the topic. Interviewee E5 stated that he had witnessed the practice of co-processing in Fortaleza and Maracanaú, specifically in the use of wood waste as an alternative fuel. This account indicates that, although there is some specific knowledge about the use of waste for energy purposes, there is still a general lack of awareness—even among civil construction professionals—that co-processing is a regulated practice and restricted to cement industries, as established by CONAMA Resolution No. 264/1999, which deals with environmental licensing for rotary kilns in clinker production.
Furthermore, when asked about communication from cement suppliers regarding the practice of co-processing, it was expected that most interviewees would respond negatively. This expectation was confirmed: all participants stated that they had not received direct information from suppliers on the topic. Moreover, interviewee E3 noted that such information is usually directed to the companies' purchasing departments and not necessarily to the engineers responsible for the projects. This finding suggests a failure in internal communication between purchasing and engineering departments, hindering full awareness of the sustainable practices adopted by cement companies.
Interviewee E4 added to this analysis by pointing out that:

"No, not really, I have personally had quite a bit of difficulty obtaining information from cement manufacturing companies. They are closed companies that totally restrict information when we need it." (E4)

When the interviewees were asked whether they had knowledge about energy cogeneration, they responded as follows:

"I must confess that I don't have knowledge or much depth to talk about it; what I know is that it's a combined thermal energy generation [...]" (E2)
"I have never had any knowledge about energy cogeneration and I really don't know about it." (E3)
"Yes, I know the process of energy cogeneration; there are some types like solar, wind, both industrial and residential." (E4)
"I don't know about energy cogeneration related to the cement industry. I've heard about [...] the use of biomass for energy generation [...]" (E5)
"No." (E6)
"I don't know about energy cogeneration." (E7)

Given the widespread lack of knowledge among the interviewees about the practice of energy cogeneration in the cement industry, they were asked whether cement suppliers had ever formally communicated this information. As expected, all participants confirmed that they had never received guidance or informational materials on the topic from suppliers.

Next, the study sought to identify how suppliers communicate their product portfolios to purchasing companies. Interviewee E3 reported that "contact is made directly with the purchasing department," indicating that technical communication does not reach the engineers responsible for the construction projects directly. Interviewee E4 highlighted the difficulty in obtaining specific information, stating that it is "virtually impossible to obtain information about the composition of slag or other materials used in the cement supplied by the industry." Interviewee E7, in turn, stated that the cement supplier communicates its product portfolio institutionally, without technical details.

Interviewee E5 reported not recalling any specific information but said he receives marketing emails and direct mailings from cement companies. Interviewees E2 and E6 stated that they were unaware of any structured form of communication from suppliers regarding technical details of the products. These results demonstrate a gap in technical-commercial communication in the cement market, limiting the dissemination of relevant information about sustainable attributes and material composition.

V. CONCLUSIONS

This research aimed to analyze the perception of central attributes associated with cement—especially cement produced with sustainable practices—among civil engineers working in the state of Maranhão. The analysis was based on Centrality Theory, considering its four main dimensions: concept, category, diagnosis, and salience.

The results indicated that the interviewees recognize strength, resistance, and durability as central attributes of cement, regardless of whether the product is traditional or sustainable in origin. This perception reveals the stability of the concept of cement in the minds of construction professionals, even as sustainable practices are being progressively incorporated into the sector.

It was observed that the concept of strength and durability associated with buildings and construction remains unchanged for most participants, even with the introduction of ecological cements, such as CPII-E and CPIII, which incorporate blast furnace slag in their composition. This finding is relevant for the cement industry, as it demonstrates that the adoption of environmental practices does not compromise the technical identity of the product in the business market.

However, it was also found that the civil construction industry still has a limited view of environmental sustainability. Despite growing concern with waste management, reduced water and energy consumption, and the pursuit of environmental certifications, the communication of sustainable technologies applied to material production—such as waste co-processing and energy cogeneration—is still incipient. In particular, it is noted that ecological cement is seldom publicized as an environmentally responsible product, which limits its potential for awareness and appreciation by institutional buyers.

It is important to emphasize that the proposal is not to label sustainable cement simply as "green cement" on packaging or in marketing, but rather to inform, in a technical and transparent way, the environmental impact reduction practices adopted in the production process. In this way, the cement industry can effectively contribute to sustainable development, promoting the preservation of natural and energy resources, as well as generating social and economic benefits that meet the needs of present and future generations.

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