SemeAd 2024
XXVII Seminários em Administração

05, 06, 07 e 08 de novembro de 2024
ISSN 2177-3866

Institutional arrangements for sustainable maintenance of residential condominiums

MARCO ANTONIO PORTUGAL
CENTRO UNIVERSITÁRIO DA FUNDAÇÃO EDUCACIONAL INACIANA PE SABÓIA DE MEDEIROS (FEI)

Agradecimento à orgão de fomento:
This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

TITLE: Institutional arrangements for sustainable maintenance of residential condominiums

1. INTRODUCTION

Housing is fundamental to the physical and social integrity of human beings, making civil construction an essential activity to provide positive impacts on society (Gómez et al., 2023).

Even with the growth of the construction industry, approximately 1.6 billion people around the world still live in inadequate housing, with 1 billion living in slums and informal settlements (Boateng & Adams, 2022), highlighting the importance of this sector in addressing social issues. However, the activity also has negative impacts on sustainability.

The sector accounts for a third of global energy consumption and 40% of raw materials consumption (Choi, 2019). The construction and operation of buildings makes the sector one of the main contributors to CO2 emissions, accounting for around 37% of global emissions (United Nations Environment Programme, 2022), in addition to the generation of waste in landfills, dust emissions, noise disturbances and traffic restrictions (Kennedy et al., 2007).

To minimize its negative effects, the construction sector has increasingly developed and employed innovative materials and construction process solutions that aim to increase its sustainability. These measures would be aligned with the UN 2030 Agenda and its Sustainable Development Goals (SDGs), which seek to guide the path towards a more sustainable society. However, despite all these efforts being valid, the level of implementation of the SDGs in construction is still considered low (Kim & Chang, 2022).

Vertical buildings around the world, from small buildings to skyscrapers, require periodic maintenance and constantly consume energy and water to operate. These buildings are contributing to the degradation of the planet's natural resources and accelerating climate change, posing a threat to human prosperity and security (Beim, 2023).

While construction companies are increasingly focused on sustainability, building owners often lack the necessary knowledge and engagement to operate and maintain their buildings sustainably, indicating a need for strategic approaches and further studies in effective building maintenance practices (Olanrewaju, 2022).

Given this context, the question arises: What are the challenges in encouraging the sustainable maintenance of residential condominiums?

The study employed qualitative methods, including document collection, participant observation, and structured questionnaires, within a case study conducted in Brazil, utilizing multiple data collection techniques to ensure reliable results through data triangulation (Stake, 2013).

This research aims to identify effective means for the transition to sustainable maintenance in residential condominiums, addressing the challenges and limited implementation of sustainable practices, while highlighting the lack of studies in this field (Olanrewaju, 2022).

One of the examples to justify carrying out the research is the lack of awareness and knowledge on the part of owners regarding the benefits of sustainable maintenance (Ijagbemi et al., 2022). It is essential to understand how to disseminate information effectively to demonstrate the positive impacts that adequate maintenance can have on sustainability.

This research aims to contribute to the literature and promote long-term sustainability in the construction sector. It can inform the development of public policies that encourage sustainable practices in residential condominium maintenance.

2. THEORETICAL FOUNDATION

The construction sector has strived to implement its transition to sustainability, integrating environmental and social considerations into decision-making, along with economic factors. To this end, the sector adopted the UN's 17 Sustainable Development Goals (SDGs) as a relevant sustainability model, however, challenges still need to be faced (Diaz Gonçalves & Saporiti Machado, 2023).

Furthermore, there is a need for a life cycle approach to assess sustainable development in construction, considering economic, environmental, and social factors (Wang & Ramakrishnan, 2022) into the long-term development of the sector (Cruz et al., 2019).

In any case, sustainability solutions in construction have focused on sustainable products and services, without sustainable construction management (Marcelino-Sádaba et al., 2015), however, little is known about how construction companies operate sustainability in the delivery of their projects (Ullah et al., 2020). Neglecting the effective consumption of sustainable products and services throughout their life cycle would undermine the potential for achieving true sustainability benefits from them.

Regular maintenance is crucial to extending the life of construction projects, increasing durability, saving costs, and improving safety (Germanà, 2023; Ramadan et al., 2023). Maintenance activities must cover sociocultural, technical, and managerial aspects, considering key topics such as tradition, consumerism, sustainability, and digitalization (Germanà, 2023). Maintenance in the field of construction goes beyond prolonging quality levels for direct users and has important social and collective implications for public and private buildings and spaces (Dzulkifli et al., 2021).

Associated with the fact that there is a lack of studies that offer strategic approaches to sustainable and effective building maintenance practices (Olanrewaju, 2022), the application of Life Cycle Sustainability Assessment (ASCV) in the construction industry is still limited and presents significant challenges. Although Life Cycle Assessment is widely used to measure the environmental impacts of products and materials, ASCV, which encompasses the environmental, social, and economic aspects of sustainability, is still little explored in this sector (Krutilova et al., 2023). Furthermore, the evaluation currently practiced, which emphasizes the production phase, presents gaps in social and economic aspects (Backes & Traverso, 2021).

One standardizing system boundaries and input parameters in Life Cycle Assessment and Life Cycle Costing methods is necessary to effectively address building performance issues and assess environmental objectives and costs throughout the life cycle of buildings (Schneider-Marin et al., 2022), considered from the design phase to maintenance, to improve economic performance and promote sustainable construction (Dalla Valle, 2023; Regina Garcez, 2022).

Even if the ASCV were fully applied, the involvement of building managers in the phases of the project life cycle is relatively low, which hinders the effective delivery of the project and increases challenges during the operation and maintenance phase (Hassanain et al., 2023), causing uncertainty in the decision-making process. of decisions (Ensafi et al., 2023).

Early engagement of facilities management technicians, providers, owners, and users during the planning phase has a significant impact on the quality of the final building and its potential for long-term value creation (Boge et al., 2021). However, there are challenges that impede early involvement by building managers, such as clients' refusal to commit greater capital, the need for additional training, and the lack of incentives designed to increase the sustainability of projects (Borg et al., 2020).

Building managers face challenges such as reliance on team knowledge, inconsistent data collection, and uncertainty in decision-making, which are compounded by owners' lack of awareness and knowledge about the benefits of sustainable maintenance (Ijagbemi et al., 2022), represent significant and complex obstacles to be faced (Ensafi et al., 2023).

The challenges become even greater given the greater complexity of sustainable construction, associated with higher maintenance costs (Osunsanmi et al., 2022). This makes it crucial that owners understand the economic benefits of continuing to perform building maintenance satisfactorily.

Maintenance is often deemed as an unpleasant activity in construction due to its focus on error correction and ensuring efficient building performance, yet its costs are not always sufficiently considered during the design phase despite their significant impact on a building's operating budget (Othman & Kamal, 2023). This culminates in owners' insufficient perception of the need for maintenance to preserve the integrity of their assets, especially regarding sustainable aspects (Ijagbemi et al., 2022).

2.1. Institutional arrangements over the condominium life cycle

Institutional arrangements can be defined as the structures, rules and mechanisms that govern the interactions and behaviors of actors in a particular context (Fomenko & Kotelevskaya, 2023; Schlager et al., 2022; Schlager & Villamayor-Tomas, 2023). These provisions are crucial for understanding policy-making processes, resolving social dilemmas, and achieving shared results (Schlager et al., 2022; Schlager & Villamayor-Tomas, 2023).

A comprehensive understanding of institutional arrangements is crucial for effective governance and decision-making, as they shape behavior and outcomes in organizations and societies globally, including the functional structure of the Brazilian real estate market examined in this study.

1. Project: Feasibility studies are carried out, definition of project characteristics (design) and obtaining necessary licenses and authorizations. Law Nº. 4.591/1964, known as the Condominium Law (Brazil, 1964), establishes rules for real estate development and condominiums in buildings in Brazil.
2. Assigned equity: Legal guarantee that separates the assets and liabilities of each real estate project, protecting buyers against financial risks. Law Nº. 10.931/2004, in its article 31-A, deals with allocated assets (Brazil, 2004).
3. Launch: Stage in which the project is publicized and commercialized. Information about the project, available units, prices, payment terms and delivery times is presented. Law Nº. 8.078/1990 deals with the Consumer Protection Code (Brazil, 1990) and establishes rights and duties to protect consumers during the property purchase process.
4. Commercialization: Sales of the project's units are carried out. Purchase and sale contracts are signed between buyers and the entrepreneur. Law Nº. 6.766/1979 provides for the division of urban land and establishes rules for the sale of subdivisions and subdivisions (Brazil, 1979).
5. Construction: A construction company is hired to carry out the infrastructure works and housing units. The Building Performance Standard (ABNT NBR 15.575) establishes minimum quality and performance requirements for residential buildings in Brazil (Associação Brasileira de Normas Técnicas, 2013).
6. Delivery of properties to owners: The units are delivered to buyers. Inspection procedures for the delivery of properties are carried out, including issuing receipt terms, and resolving any errors or defects. The Brazilian Civil Code (Law Nº. 10.406/2002) establishes general rules on the transfer of real estate property (Brazil, 2002).
7. Consolidation of the condominium: After the units are delivered, the condominium is consolidated. The owners organize themselves in a condominium implementation assembly , elect a manager and define rules for coexistence and administration of the condominium. Law Nº. 10.406/2002, in its article 1.331, deals with the institution and operation of the building condominium.

In Brazil, the role of a condominium manager is typically fulfilled by a condominium owner who meets the legal requirements, but condominiums also have the option to hire a professional administrator or a specialized company for the position, as there are no specific restrictions imposed by law regarding professional occupation, academic training, or other qualifications for the role of a liquidator (Brazil, 1964).

The property manager, among his legal functions, is responsible for the maintenance of the condominium, established both in the Condominium Law (Brazil, 1964)and in the Brazilian Civil Code (Brazil, 2002).

According to article 1,348 of the Civil Code, the property manager has the duty to "ensure the conservation and custody of the common parts and ensure the provision of services that are of interest to the owners" (Brazil, 2002). This includes responsibility for the maintenance and conservation of the condominium's common areas, such as elevators, electrical and hydraulic systems, leisure areas, among others.

Furthermore, article 22 of the Condominium Law establishes that the property manager is responsible for "actively and passively representing the condominium, carrying out, in court or out of court, the acts necessary to defend common interests" (Brazil, 1964). This active representation includes taking measures to ensure adequate maintenance and upkeep of the common areas of the condominium.

It is worth noting that, in addition to the legal provisions, the condominium agreement can also establish specific guidelines and responsibilities for the property manager in relation to the maintenance of the condominium.

2.2. ASCV in construction

The fundamental principles of sustainable life cycle theory in the construction industry can be summarized in the form of the ASCV, a framework that assesses the environmental, economic, and social impacts of construction projects throughout their life cycle (Dong et al., 2023). Through ASCV, decision makers can compare the relative sustainability of different materials, design approaches, construction methods, and construction operation alternatives (Tran et al., 2023).

The challenges regarding the ten principles (10P) for applying the ASCV (Valdivia et al., 2021) may perhaps prove to be too many for civil construction and not be fully applied, as pointed out by Dong et al. (2023). Furthermore, the integrative review of the study did not result in a classification of the 10P per phase of the construction project, which has the peculiar characteristic of having a life cycle lasting decades.

The extension of the building maintenance life cycle presents challenges to implementing ASCV and affects the sustainability of residential condominiums, highlighting the need for further research in this area (Nazari et al., 2019; Nokleberg & Hawkes, 2021).

In this sense, the peculiar structure of the Brazilian real estate market has proven to be a challenge for the implementation of ASCV, since it presents all the characteristics previously described in the theory on the subject.

3. METHODOLOGY

The argument to justify the methodological choice of this study was based on the robustness and validity of the methods used, as well as the relevance and representativeness of the context studied (Shally et al., 2023; Yang, 2021). Along these lines, the construction industry in Brazil plays a crucial role in the country's economy (Silva et al., 2023). The choice to focus on residential condominiums in this country proved to be a relevant case study, as this

is one of the main types of construction projects in the country. In it, condominiums have grown rapidly and have several impacts on urban development, social segregation, and environmental degradation (Souza et al., 2022). Furthermore, the diversity of characteristics of each Brazilian region contributed to making the generalization of the results of this research difficult.

The study was exploratory in nature, focusing on investigating a subject that is not well-known or extensively explored. Exploratory research is conducted when there is limited information available on the topic, aiming to gain initial and in-depth understanding, generate insights, and form hypotheses for future research (Creswell & Creswell, 2017).

A methodological approach was adopted that combined the collection of primary data through a questionnaire and participant observation, and secondary data through documentary research.

A structured questionnaire was developed to collect primary data from homeowners in Brazil, specially designed to gather information that could be used to identify the categories of analysis, with questions directed based on the literature and adapted for this qualitative study (Creswell & Creswell, 2017).

Built and distributed online using the Tripetto tool, the questionnaire reached a diverse and significant sample of condominium owners in Brazil. To increase the response rate, a broad dissemination strategy was adopted, including partnerships with associations in the construction sector, publications on social networks and sending via electronic direct mail to a network of contacts.

In parallel, a document analysis was conducted on the collection of relevant secondary data was contributed to an even more comprehensive understanding of the topic. The sample for document collection was selected using a convenience approach, considering criteria of accessibility and geographic representativeness. To this end, the largest municipality in each region of Brazil (Table 1) in terms of number of inhabitants was considered.

Table 1
Municipalities with the highest number of inhabitants by region in Brazil

Region	state	County	Number of inhabitants
North	Amazon - AM	Manaus	2,063,629
Northeast	Ceará - CE	Strength	2,428,708
Midwest	Federal District - DF	Brasilia	2,817,381
Southeast	Sao Paulo-SP	São Paulo	11,451,999
South	Paraná - PR	Curitiba	1,773,718

Source: Author (2023), prepared with data from the Instituto Brasileiro de Geografia e Estatística (IBGE) (2023)

To identify sustainable construction projects, public access documents from construction companies and developers located within the specified municipalities were collected, while public databases were searched for documents pertaining to the real estate market and its regulations on property sustainability, including public administration regulations obtained through the portal <https://leismuncipais.com.br/>. In the case of Brasília, referring to the Government of the Federal District, the data was searched on the portal <https://www.cl.df.gov.br/leis-distritais>.

Finally, the portal <https://legislacao.presidencia.gov.br/> searched for the existence of national legislation pertinent to the subject.

The study also included data collection through participant observation. In this approach, the object of analysis was a residential condominium with 80 units, 4 housing units per floor, located in the city of São Paulo, in Brazil. The relevance of this case is that it is a project certified by the AQUA-HQE™ Process, being the pioneer in Brazil in this certification.

This is an environmental and sustainability certification for buildings, used in Brazil and is based on specific criteria and indicators to evaluate and promote the environmental quality of real estate projects. Certification is awarded to projects that meet the requirements established by the process until the construction completion phase, demonstrating their commitment to sustainability and people's well-being (Fundação Vanzolini, n.d.).

Participant observation was employed as a data collection method, involving the researcher's active involvement as the condominium manager in the residential condominium from April to October 2022. This timeframe was deemed suitable for capturing relevant information for the research objective.

Furthermore, other relevant information and insights were collected and used since the project's delivery, which took place in 2013. It is worth noting that the researcher played the role of owner and resident of the condominium since its delivery, which provided a privileged perspective and understanding depth of the context studied. This information and personal perceptions were incorporated into the study, enriching the analysis, and contributing to a more comprehensive understanding of the topic.

In these approaches, no ethical aspects were identified that would justify being previously addressed, since none of the final collection notes attempted to express nominal data. The information gathered resulted exclusively from the researcher's own records, without compromising the identity of the condominium or the people and companies involved.

The contribution of participant observation was limited to the consideration of confirmatory data, that is, those that were also obtained through other data collection methods. Thus, the triangulation of information from different data collections provided greater reliability in the results and helped to mitigate the risk of bias (Stake, 2013).

Finally, the data was organized into analysis categories, related to the research question, and guided by the literature, to obtain results through data interpretation (Bowen, 2009).

For categorization and data analysis, we followed what was proposed by Eisenhardt (1989). The interpretative analysis of the relationships between the categories of information was the starting point of this process, eliminating the need for prior formulation of hypotheses.

The analysis categories were defined using an open grid approach, offering flexibility for the creation and modification of categories throughout the research process until finalized by the researcher. These categories were classified into first order, based on documentary references, and second order, with defined definitions to facilitate the analysis. This strategy ensured a rigorous connection between the collected data and the obtained results (Gioia et al., 2013).

The conclusions obtained from this research provided important insights for the promotion of effective strategies that encourage sustainable maintenance in residential condominiums, contributing to the adoption of more sustainable practices in the construction sector.

4. DISCUSSION OF RESULTS

This research utilized a mixed-methods approach, collecting primary data through a structured questionnaire and participant observation, as well as secondary data through documentary research. The structured questionnaire yielded 94 validated observations from participants who were owners or residents of condominium properties, aged 18 years or older. The questionnaire included questions aimed at assessing respondents' understanding in five categories of analysis, the results of which are presented alongside the respective categories in the Appendix of this article.

1. Perception: Many respondents (79%) expressed a strong interest in the sustainability of their properties and called for greater action from city halls to promote sustainability. They also believed that laws and public policies are necessary for sustainable property maintenance.
2. Importance: Most respondents (79%) attributed a high level of importance to property sustainability. However, when it comes to economic considerations, only 57% of respondents were willing to bear higher costs for sustainable maintenance or invest in transforming older properties into more sustainable ones.
3. Incentive: Economic and legal factors were seen as strong motivators by most respondents (76%) to encourage construction companies to promote sustainable properties. Reputation, marketing, and societal pressure were considered irrelevant motivators by nearly half of the respondents (45%).
4. Knowledge: Nearly half of the respondents (47%) felt they had sufficient knowledge for sustainable maintenance. However, the majority (73%) found these tasks challenging, and 82% felt they did not receive enough information from construction companies regarding property maintenance, indicating a low perception of affordable sustainable property offerings.
5. Relevance: Many respondents (82%) recognized the importance of sustainability in various aspects, including resource consumption and the impact of construction projects on the neighborhood.

These categories of analysis, previously defined based on the literature, made it possible to create a questionnaire that gathered consistent results on aspects related to the sustainability of property maintenance by their owners and residents. Therefore, the same structure of categories was followed to be compared by the other stages of this research.

The information collected through participant observation, presented, and discussed below, corroborated the results obtained by consolidating the answers to the questionnaire questions, within the same structure of proposed categories.

The analyzed enterprise presented, through its AQUA-HQE™ Process certification, a strong sustainable appeal. However, the fact that the project was believed to be sustainable did not prove to be completely sufficient to guarantee that there was, on the part of the 7 managers responsible for the condominium throughout the almost 10 years of its operation, a full perception regarding the need to exercise sustainable maintenance practices. Furthermore, when asked, not only many property managers, but also a good number of condominium owners, were not even aware of the existence of such a certificate.

Transitions from the construction company to the condominium and between administrators lacked formal communication of the condominium's history. The only available record was the minutes of condominium owners' meetings, which focused mostly on financial matters. The construction company provided a basic maintenance manual and construction drawings but did not offer detailed information on operating the building's equipment. It was the condominium's responsibility to discover this information and address any faulty installations during the warranty period. Over time, maintenance and operational history could be lost, leading to issues such as deactivated solar panels and manual operation of automated systems.

This lack of knowledge and formal history hindered effective monitoring and decision-making regarding sustainability aspects. For instance, it took almost a decade to realize that the Gray Water Treatment Plant (ETAC) system operated inefficiently, resulting in higher costs than using drinking water. The absence of records for the 28 water pumps in the building led to unnecessary equipment replacements and overlooked preventative maintenance needs.

Overall, the focus on minimizing perceived costs in operational maintenance neglected one-off preventative measures and created dependence on external parties, employees, and service providers. This insecurity in decision-making and the lack of ASCV implementation highlight the absence of measures aimed at extending the building's life cycle, reducing maintenance costs, promoting social relations, and decreasing resource consumption in the surveyed locations.

In Brazil, property owners are taxed by the tax called Urban Property and Territorial Tax (IPTU), provided for by art. 156 of the Federal Constitution (Brazil, 1988), which is why measures that aim to generate incentives through this tax waiver would first require a review of the Magna Carta.

This is what the Proposed Amendment to the Constitution (PEC) 13/2019 is about, considered as an incentive for sustainability (Agência Senado, 2022). However, the text that was approved by the Federal Senate appears incipient in this sense.

This PEC offers the possibility of encouraging “the use of rainwater, the reuse of wastewater, the local treatment of wastewater, the recharge of the aquifer, the use of green roofs, the degree of soil permeabilization and the use of renewable energy in the immobile" (Senado Federal, 2022). If this remains the case until its final approval, this change in the Federal Constitution will result in a limited opening of incentives by reducing the IPTU rate.

This is what can be concluded when comparing it with the 81 sustainable measures of the IPTU Verde program in the municipality of Salvador. The Agência Senado (2022) mentioned the existence of IPTU Verde in the Federal District and other similar initiatives in another 5 Brazilian municipalities, however, the municipality of Salvador is the only one that has a program in force that is related to the proposal for the sustainability of urban properties.

Despite the inconsistency with the Federal Constitution, Salvador's Green IPTU measure seeks to encourage properties to adopt sustainable practices, offering gradual discounts on IPTU that can reach up to 10% for those who reach 100 or more points in the certification program's list of measures. sustainable development of the city hall (Prefeitura de Salvador, n.d.).

While a 10% incentive may not seem appealing, the program offers 752 possible points, allowing participants to earn 100 points by fulfilling just a few or even a single sustainable measure out of the 81 provided. This highlights the challenge of designing a program that effectively promotes sustainability in construction and real estate. It is crucial to strike a balance between desired sustainable indicators and the incentives provided. Without this balance, there is a risk of low participation or reduced tax revenue for municipalities.

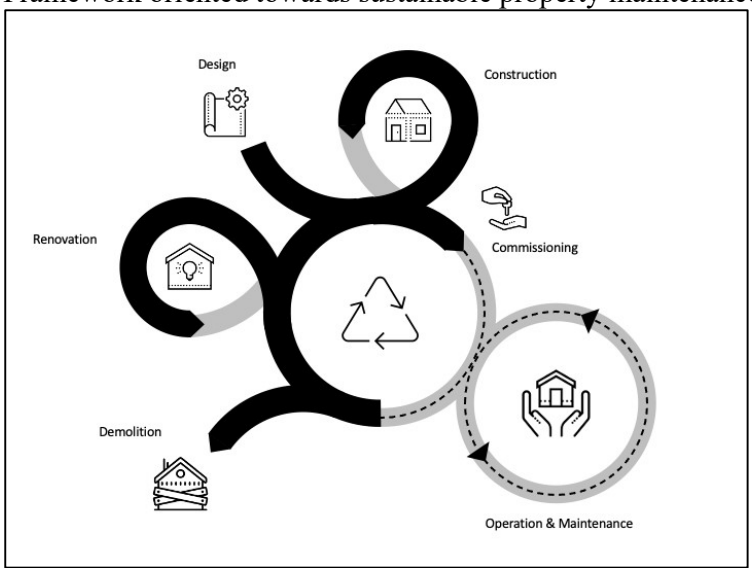
To achieve balance within the sustainability framework, public policies should prioritize regulation and inspection rather than relying solely on tax exemptions, as a 10% incentive may be deemed excessive.

However, existing initiatives fail to account for the condition of properties, treating all properties equally regardless of whether they are under construction, newly built, or have been in use for many years. It is widely acknowledged that existing properties encounter more challenges in adopting ASCV compared to newly constructed ones, such as the hurdle of water consumption individualization, which is commonly implemented in new properties but remains a challenge in older ones, resulting in higher water consumption.

Addressing the age of a property and its connection to ASCV should also apply to property taxes (IPTU). However, the prevailing practice throughout the country still favors older properties. The IPTU charge decreases with the age of the property and can even lead to total tax exemption, while newly constructed properties are fully taxed.

Finally, the results of this research led to the development of the proposed model for sustainable maintenance, illustrated in Figure 1.

Figure 1
Framework oriented towards sustainable property maintenance.



Source: Prepared by the Author (2023).

Figure 1 illustrates a model with 6 stages, where Operation & Maintenance is repeated systematically. The Design stage sets the foundation for the entire cycle, addressing sustainability considerations for Construction and Operation & Maintenance. Sustainable design aims to extend the product's life cycle and optimize Operation & Maintenance and Renewal stages.

During the Construction stage, sustainable planning and adherence to configurations are crucial. Promoting projects that offer operational benefits and lower maintenance costs is essential. The commissioning stage should be implemented between Construction and Operation & Maintenance to transfer knowledge to the condominium's technical team.

The Operation & Maintenance phase involves following the maintenance plan, documenting preventive and corrective interventions, and possessing the necessary technical and administrative competence. This phase is repeated if viable within the context of ASCV, only interrupted by renovations or when the building reaches the end of its life cycle and requires demolition.

Renovation, an intermediate stage in ASCV, can also serve as an initial stage for non-sustainably designed constructions.

Table 2 indicates the main concentration for the 5 operational stages in Figure 1, with the findings of the analysis categories of this study and the challenges regarding the 10P for applying ASCV presented by Valdivia et al. (2021).

Table 2
ASCV Challenges in Real Estate

Design	**Construction**	**Commission-ment**	**Operation & Maintenance**	**Renovation**
Incentive	Perception	Knowledge	Relevance	Importance
P1 – understanding of protection areas. P2 – alignment with ISO 14040. P9 – explicit communication of *trade-offs*.	P8 – transparency.	P4 – consideration of key stakeholders.	P3 – completeness; P10 – caution when compensating for impact.	P5 – consideration of the usefulness of the product; P6 – materiality of system limits; P7 – consistency.

Source: Author (2023), prepared based on Valdivia et al. (2021).

Figure 1 and Table 2 provide valuable guidance for formulating public policies that promote the adoption of ASCV (Alternative Sustainable Construction and Renovation) in both new and existing properties. Tailoring public policies to address the specific needs and challenges of each type of property is crucial.

For new properties, regulations should be established to incentivize the use of sustainable technologies and materials throughout the construction process. This can include requirements for sustainability certifications, tax incentives for sustainable buildings, and architectural guidelines that prioritize energy efficiency and environmental impact reduction.

Existing properties require different approaches, such as retrofit programs aimed at updating and enhancing their sustainability. Public policies can offer financial incentives, special lines of credit, and technical assistance to support owners in making the necessary improvements.

In addition, public policies should prioritize raising awareness and providing training for construction professionals, as well as educating and engaging the general population. This is essential to ensure understanding of the benefits of ASCV practices and to foster a cultural shift towards sustainability.

5. CONCLUSIONS

This study emphasized the positive outcomes of life cycle assessment in sustainable maintenance of residential condominiums. It highlighted the significance of creating awareness among homeowners regarding the benefits of sustainability in project development.

The lack of knowledge and involvement of homeowners poses a major challenge in implementing sustainable practices in residential condominium maintenance, needing for public policies that promote sustainability in this sector. It is important to note that this study was based on a specific case study, but there are opportunities to expand the research to other scenarios for a more comprehensive understanding of the challenges and opportunities in sustainable maintenance. Developing a quantitative structural model could contribute to a more precise analysis of the impacts and benefits of sustainability in this context.

These findings have significant implications for promoting sustainability in construction. Raising homeowner awareness about sustainable maintenance can lead to behavioral changes and the adoption of more sustainable practices, and result in more efficient buildings with reduced environmental impact.

This study enhances our understanding of the challenges and opportunities in sustainable maintenance of residential condominiums. Expanding the research to other situations and developing a quantitative structural model are crucial steps to deepen knowledge and promote sustainable practices in construction.

FUNDING

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

REFERENCES

Agência Senado. (2022, December 13). *Senado autoriza redução no IPTU como incentivo à preservação ambiental*. Agência Senado. https://www12.senado.leg.br/noticias/materias/2022/12/13/senado-aprova-pec-do-iptu-verde-em-votacao-unanime

Associação Brasileira de Normas Técnicas. (2013). *ABNT NBR 15.575: Edificações habitacionais - Desempenho*. Associação Brasileira de Normas Técnicas.

Backes, J. G., & Traverso, M. (2021). Application of Life Cycle Sustainability Assessment in the Construction Sector: A Systematic Literature Review. *Processes*, *9*(7), 1248. https://doi.org/10.3390/pr9071248

Beim, A. (2023). Ecologies of Tectonics. *Technology|Architecture + Design*, *7*(1), 20–23. https://doi.org/10.1080/24751448.2023.2176129

Boateng, G., & Adams, E. (2022). A Novel Measure of Housing Insecurity, Poverty and Use of Unclean Cooking Fuel Are Associated With Greater Food Insecurity in Slums and Informal Settlements. *Current Developments in Nutrition*, *6*, 94. https://doi.org/https://doi.org/10.1093/cdn/nzac051.010

Boge, K., Haddadi, A., Klakegg, O. J., & Salaj, A. T. (2021). Facilitating Building Projects' Short-Term and Long-Term Value Creation. *Buildings*, *11*(8), 332. https://doi.org/10.3390/buildings11080332

Borg, R., Dalli Gonzi, R., & Borg, S. (2020). Building Sustainably: A Pilot Study on the Project Manager's Contribution in Delivering Sustainable Construction Projects—A Maltese and International Perspective. *Sustainability*, *12*(23), 10162. https://doi.org/10.3390/su122310162

Bowen, G. A. (2009). Document Analysis as a Qualitative Research Method. *Qualitative Research Journal*, *9*(2), 27–40. https://doi.org/10.3316/QRJ0902027

Brazil. (1964). *Lei nº 4.591/1964. Dispõe sobre o condomínio em edificações e as incorporações imobiliárias.* Senado Federal.

Brazil. (1979). *Lei nº 6.766/1979. Dispõe sobre o Parcelamento do Solo Urbano.* Senado Federal.

Brazil. (1988). *Constituição da República Federativa do Brasil*.

Brazil. (1990). *Lei nº 8.078/1990. Dispõe sobre a proteção do consumidor e dá outras providências.* Senado Federal.

Brazil. (2002). *Lei nº 10.406/2002. Institui o Código Civil.* Senado Federal.

Brazil. (2004). *Lei nº 10.931/2004. Dispõe sobre o patrimônio de afetação de incorporações imobiliárias, Letra de Crédito Imobiliário, Cédula de Crédito Imobiliário, Cédula de Crédito Bancário e dá outras providências.* Senado Federal.

Choi, J. (2019). Strategy for reducing carbon dioxide emissions from maintenance and rehabilitation of highway pavement. *Journal of Cleaner Production*, *209*, 88–100. https://doi.org/10.1016/j.jclepro.2018.10.226

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Cruz, C. O., Gaspar, P., & de Brito, J. (2019). On the concept of sustainable sustainability: An application to the Portuguese construction sector. *Journal of Building Engineering*, *25*. https://doi.org/10.1016/j.jobe.2019.100836

Dalla Valle, A. (2023). *Life Cycle Assessment at the Early Stage of Building Design* (pp. 461–470). https://doi.org/10.1007/978-3-031-29515-7_42

Diaz Gonçalves, T., & Saporiti Machado, J. (2023). Origins of the Sustainability Concept and Its Application to the Construction Sector in the EU. *Sustainability (Switzerland)*, *15*(18). https://doi.org/10.3390/su151813775

Dong, Y., Ng, S. T., & Liu, P. (2023). Towards the principles of life cycle sustainability assessment: An integrative review for the construction and building industry. *Sustainable Cities and Society*, *95*, 104604. https://doi.org/10.1016/j.scs.2023.104604

Dzulkifli, N., Sarbini, N. N., Ibrahim, I. S., Abidin, N. I., Yahaya, F. M., & Nik Azizan, N. Z. (2021). Review on maintenance issues toward building maintenance management best practices. *Journal of Building Engineering*, *44*, 102985. https://doi.org/10.1016/j.jobe.2021.102985

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *The Academy of Management Review*, *14*(4), 532. https://doi.org/10.2307/258557

Ensafi, M., Thabet, W., Afsari, K., & Yang, E. (2023). Challenges and gaps with user-led decision-making for prioritizing maintenance work orders. *Journal of Building Engineering*, *66*, 105840. https://doi.org/10.1016/j.jobe.2023.105840

Fomenko, N., & Kotelevskaya, Y. (2023). Aspects of forming the institutional mechanism for organization management. *E3S Web of Conferences*, *380*. https://doi.org/10.1051/e3sconf/202338001028

Fundação Vanzolini. (n.d.). *AQUA-HQE™*. Retrieved November 12, 2023, from https://vanzolini.org.br/certificacao/sustentabilidade-certificacao/aqua-hqe/

Germanà, M. L. (2023). A reckoning with the maintenance of the built environment, a Sisyphean task. *VITRUVIO - International Journal of Architectural Technology and Sustainability*, *8*, 34–45. https://doi.org/10.4995/vitruvioijats.2023.18804

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking Qualitative Rigor in Inductive Research. *Organizational Research Methods*, *16*(1), 15–31. https://doi.org/10.1177/1094428112452151

Gómez, S. A. S., Guerrero, F. G., & Cubides, P. A. S. (2023). The rights of the poor in Colombia: Position of the Constitutional Court | Los derechos de los pobres en Colombia: Postura de la Corte Constitucional. *Juridicas CUC*, *19*(1), 125–162. https://doi.org/10.17981/juridcuc.19.1.2023.05

Hassanain, M. A., Zourob, M. A., & Ibrahim, A. M. (2023). Analysis of FM involvement during project Lifecycle phases. *Journal of Facilities Management*. https://doi.org/10.1108/JFM-12-2022-0127

Ijagbemi, C. O., Olajide, E. B., Olajide, S. E., & Olajide, S. E. (2022). Toward Tackling the Challenge of Housing Project Abandonment through the Stakeholders' Theory. *The International Journal of Humanities & Social Studies*. https://doi.org/10.24940/theijhss/2022/v10/i9/HS2209-019

Instituto Brasileiro de Geografia e Estatística (IBGE). (2023, October 27). *Tabela 4709: População residente, Variação absoluta de população residente e Taxa de crescimento geométrico*. Instituto Brasileiro de Geografia e Estatística (IBGE). https://sidra.ibge.gov.br/tabela/4709

Kennedy, C., Cuddihy, J., & Engel-Yan, J. (2007). The changing metabolism of cities. *Journal of Industrial Ecology*, *11*(2), 43–59.

Kim, S., & Chang, S. (2022). *Construction Project Level-based Environmental, Social, and Governance (C-ESG): A Review*.

Krutilova, M., Naumov, A., & Strokova, V. (2023). Life cycle low-carbon management system improvement of the integrated development of buildings. *Construction and Architecture*, *11*(2), 3–3. https://doi.org/10.29039/2308-0191-2023-11-2-3-3

Marcelino-Sádaba, S., González-Jaen, L. F., & Pérez-Ezcurdia, A. (2015). Using project management as a way to sustainability. from a comprehensive review to a framework definition. In *Journal of Cleaner Production* (Vol. 99, pp. 1–16). Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2015.03.020

Nazari, E., Shahriari, M. H., Khodabandeh, M. E., & Tabesh, H. (2019). Create Frameworks from Software Engineering to Health Care: A Survey. *Journal of Biostatistics and Epidemiology*, *5*(3), 216–225. https://doi.org/10.18502/jbe.v5i3.3619

Nokleberg, C., & Hawkes, B. (2021). Application frameworks. *Communications of the ACM*, *64*(7), 42–49. https://doi.org/10.1145/3446796

Olanrewaju, A. L. (2022). An artificial neural network analysis of rework in sustainable buildings. *IOP Conference Series: Earth and Environmental Science*, *1101*(2), 022003. https://doi.org/10.1088/1755-1315/1101/2/022003

Osunsanmi, T. O., Aigbavboa, C. O., Oke, A., & Onyia, M. E. (2022). Making a case for smart buildings in preventing corona-virus: focus on maintenance management challenges. *International Journal of Construction Management*, *22*(16), 3109–3118. https://doi.org/10.1080/15623599.2020.1842960

Othman, A. A. E., & Kamal, A. (2023). Enhancing building maintainability through early supplier involvement in the design process. *Organization, Technology and Management in Construction: An International Journal*, *15*(1), 34–49. https://doi.org/10.2478/otmcj-2023-0005

Prefeitura de Salvador. (n.d.). *Ações sustentáveis valem desconto no IPTU*. Prefeitura de Salvador. Retrieved November 24, 2023, from http://www.iptuverde.salvador.ba.gov.br/

Ramadan, S., Khammas, W. M., & Hameed, A. H. (2023). Evaluate the State of Building Maintenance Performance in Construction Projects: A Case Study of Iraq, Diyala. *Diyala Journal of Engineering Sciences*, 113–122. https://doi.org/10.24237/djes.2023.16210

Regina Garcez, M. (2022). ECONOMIC PERFORMANCE OF BUILDINGS THROUGH LIFE CYCLE COSTING. *Journal of Urban & Environmental Engineering*, *16*(1).

Schlager, E., Siddiki, S., & Cox, M. (2022). Methods for Analyzing Social Dilemmas and Institutional Arrangements Within the Institutional Analysis and Development Framework. In *Methods of the Policy Process*. https://doi.org/10.4324/9781003269083-8

Schlager, E., & Villamayor-Tomas, S. (2023). The IAD Framework and Its Tools for Policy and Institutional Analysis. In *Theories of the Policy Process: Fifth Edition*. https://doi.org/10.4324/9781003308201-8

Schneider-Marin, P., Winkelkotte, A., & Lang, W. (2022). Integrating Environmental and Economic Perspectives in Building Design. *Sustainability*, *14*(8), 4637. https://doi.org/10.3390/su14084637

Senado Federal. (2022, December 16). *Proposta de Emenda à Constituição n° 13, de 2019*. Senado Federal. https://www25.senado.leg.br/web/atividade/materias/-/materia/135609#tramitacao_10369040

Shally, A. A., Sotoudeh, H., & Abbaspour, J. (2023). The effectiveness of methodological elements in ranking results by relevance. *Journal of Health Administration*, *25*(4), 125–143. https://doi.org/10.22034/25.4.125

Silva, M. A. da, Conto, V. De, & Romano, F. V. (2023). CONDOMINIAL EXPANSION AND SUSTAINABILITY: 2030 Agenda contributions and the environmental certifications. *ENSUS2023 - XI Encontro de Sustentabilidade Em Projeto*, 510–523. https://doi.org/10.29183/2596-237x.ensus2023.v11.n1.p510-523

Souza, A. C. R. da R., Gomes, H. C., & Guimarães, I. F. G. (2022). A statistical analysis of the relationship of civil construction GDP to cement production in Brazil. *Research, Society and Development*, *11*(7), e27011729902. https://doi.org/10.33448/rsd-v11i7.29902

Stake, R. E. (2013). *Multiple case study analysis*. Guilford press.

Tran, D. B., Tran, V. T., Pham, X. A., & Nguyen, V. T. (2023). A General Framework for Sustainability Assessment of Buildings: A Life-Cycle Thinking Approach. *Sustainability*, *15*(14), 10770. https://doi.org/10.3390/su151410770

Ullah, M., Khan, M. W. A., Hussain, A., Rana, F., & Khan, A. (2020). A construct validation approach for exploring sustainability adoption in pakistani construction projects. *Buildings*, *10*(11), 1–17. https://doi.org/10.3390/buildings10110207

United Nations Environment Programme. (2022). *2022 Global Status Report for Buildings and Construction: Towards a Zero-emission, Efficient and Resilient Buildings and Construction Sector.* https://globalabc.org/sites/default/files/2022-11/FULL%20REPORT_2022%20Buildings-GSR_1.pdf

Valdivia, S., Backes, J. G., Traverso, M., Sonnemann, G., Cucurachi, S., Guinée, J. B., Schaubroeck, T., Finkbeiner, M., Leroy-Parmentier, N., Ugaya, C., Peña, C., Zamagni, A., Inaba, A., Amaral, M., Berger, M., Dvarioniene, J., Vakhitova, T., Benoit-Norris, C., Prox, M., … Goedkoop, M. (2021). Principles for the application of life cycle sustainability assessment. *The International Journal of Life Cycle Assessment*, *26*(9), 1900–1905. https://doi.org/10.1007/s11367-021-01958-2

Wang, X., & Ramakrishnan, S. (2022). Introduction. In *Environmental Sustainability in Building Design and Construction*. https://doi.org/10.1007/978-3-030-76231-5_1

Yang, K. (2021). Methodologies Toward a New Era of Public Administration: Diversity and Advancement. *Public Performance and Management Review*, *44*(5), 961–974. https://doi.org/10.1080/15309576.2021.1980065

ATTACHMENT

Quiz

1. Before starting, do you confirm that you are over 18 (eighteen) years of age?
2. What type of property do you live in?
3. Would you agree with the statement that the property where you live is sustainable?
4. What is your assessment of the level of performance of your local city hall in encouraging the sustainability of properties?
5. Would you agree with the statement that the existence of laws and public policies is essential to guarantee the sustainability of properties?
6. How important would you give the option for a sustainable property when choosing your next property?

7. Would you agree to maintain the sustainability of a property, even considering the higher cost of this maintenance?
8. Would you agree to carry out some renovations and implementations on the property to make it more sustainable, even if you have to bear the costs of these changes?
9. When you moved into your current property, whether owned or rented, what level of prior guidance did you receive regarding the maintenance needs of this property?
10. How much do you think you know about the maintenance necessary to maintain the sustainable differences of a property?
11. How challenging do you believe it is to maintain the sustainable differences of a property?
12. What is your perception of the level of concern among construction companies in developing and offering increasingly sustainable properties?
13. How much do you believe the following motivators can encourage construction companies to maintain sustainability in their projects?
    - Financial incentives
    - Legal incentives
    - Pressure from society/consumers
    - Marketing/reputation benefits
14. How essential do you believe that the following metrics and methodologies are for the implementation and periodic evaluation of a sustainable model in construction?
    - Gas and electricity consumption
    - CO2 emissions
    - Use of sustainable materials in the construction stage
    - Water consumption
    - Thermal and acoustic comfort
    - Green areas and green roofs
    - Permeable floors
    - Impacts on the neighborhood
    - Wide, flat sidewalk
    - Recycling and low generation of solid waste