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Integrating sustainable materials into construction: A review of Zimbabwe's Model building by-laws

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Abstract

Environmental challenges associated with the use of traditional construction materials are widespread in Zimbabwe. Despite the availability of sustainable construction materials, the failure to adopt the Model Buildings by-law of 1977 has stalled the promotion of strategic interventions. Hence, the study identified pertinent modifications to the Model building by-laws that could enable the utilisation of sustainable construction materials—the interpretivist philosophy employed semi-structured online interviews. Purposive sampling was used to solicit views from sixteen (16) construction professionals, academics, and relevant local government officials with experience in sustainable construction. The generation of modern by-laws with relevant, sustainable material specifications, design-related modifications, and the adoption of green building principles or methodologies were the major themes identified. A comprehensive stakeholder engagement was recommended to ensure that any modifications are practical and implementable. Using sustainable construction materials requires a policy intervention incorporating a comprehensive stakeholder support framework from manufacture to material disposal. The paper highlights the necessary changes to the model-building by-laws (MBBLs) to integrate sustainable construction material utilisation in Zimbabwe. This is valuable to all stakeholders in the construction industry as it aligns with the Sustainable Development Goals of climate action and responsible production and consumption. The main limitation was the exclusive use of a key-informant qualitative design rather than end users. However, the exploratory nature of the study supported the approach.

Keywords: Building regulations, Model building by-laws, Sustainable construction materials, Zimbabwe.

1. Introduction

According to the United Nations Sustainable Development Agenda (2020), sustainable development is an advancement that meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations, 2020). In addition, at the core of sustainability are three elements: economic growth, social inclusion, and environmental protection. Hence, sustainability aims to ensure that every development enables the availability of resources for everyone, meets human rights and basic needs, and consumes natural resources at a rate that allows them to replenish themselves, guaranteeing balanced ecosystems. Sustainable construction is a subset of sustainable development concentrating on managing a healthy built environment based on resource-efficient and ecological principles (Baloi, 2003). The built environment shapes the context of most human activities and accounts for a significant share of any economy; moreover, construction leaves behind environmental and carbon footprints (Brennan, 2015). The construction industry has an enormous impact on the economy, environment, and health of a nation, as it is the leading universal user of materials and one of the significant primary energy-consuming sectors, contributing significantly to atmospheric emissions (Demir & Dogan, 2020). However, due to urbanisation and globalisation, environmental deterioration and resource depletion have increased, leading to the need to alleviate resource depletion (Mathiyazhagan et al., 2019). In fact, the construction sector continues to be one of the largest global consumers of natural resources, utilising an estimated 40% of global

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extraction of non-metallic minerals (such as sand, gravel and stone) and around 25% of global timber production (Kibert, 2022). Moreover, the heightened awareness of global environmental threats, such as climate change, has led to greater interest in low-carbon embodied materials for sustainable building (Agyekum et al., 2022). Sustainable construction has been observed as the solution, requiring sustainable materials. This is because sustainable construction materials have zero environmental impact and are reusable and recyclable (Onyegiri & Ugochukwu, 2016), resulting in benefits across the economic, social, and environmental dimensions of sustainability (Eze et al., 2023).

Despite over 30 years of discourse on sustainability, the adoption of sustainable construction materials to achieve a sustainable built environment has lagged, and developing countries, such as Zimbabwe, need support in this regard (Moyo et al., 2024). Chari and Chiriseri (2014) noted that sustainability principles must be factored into procurement decisions within both private and public entities in Zimbabwe. According to the Global Climate Risk Index (2021), Zimbabwe was among the world's ten most affected countries by climate change in 2019 (United Nations Climate Technology Centre and Network (CTCN), 2022), a potential motivator for enhancing sustainable construction practices. As a result, Altuma and Ghasemlounia (2021) state that, as the construction industry continues to grow, it is essential to use innovative technologies and creative approaches to select construction materials to sustain available resources. According to Eze et al. (2023), more studies are required on the adoption of sustainable construction materials in developing countries in Africa, including Nigeria. Therefore, this study suggested modifications to the Model Building by-laws to integrate sustainable utilisation of construction materials in Zimbabwe. The concomitant objective was to identify and prioritise modifications to the 1977 MBBLs that would enable the adoption of sustainable construction materials in Zimbabwe. Sustainable construction materials are environmentally friendly and minimise environmental challenges such as ecosystem imbalances, pollution, greenhouse gas (GHG) emissions, and other issues arising from conventional building materials, which are hostile to ecosystems, unsustainable, and harmful to the environment (Eze et al., 2021). The sustainable construction materials proffered by Eze et al. (2021) are grounded in the cradle-to-cradle model (Braungart & McDonough, 2009) and the diffusion of innovation Theory (Wani & Ali, 2015), as they promote human safety through innovation-enhancing policies.

It is critical for policymakers to build a robust, sustainable economy (Mathiyazhagan et al., 2019). The following sections review the theoretical framework and related literature. Thereafter, the methodology is reported and justified. The results are presented and discussed. Finally, the conclusions and recommendations are outlined.

2. Literature Review

This section focused on the study's theoretical framework and the role of MBBLs in incorporating sustainable construction material utilisation, as proffered by previous studies.

2.1. Theoretical framework

The adoption of sustainable materials depends on multiple factors. The research used a fusion of two theories to address impacts at individual, organisational, and inter-organisational levels, as applied by Tran et al. (2020). The two theories are the cradle-to-cradle model (Braungart & McDonough, 2009), which emphasises the use of building materials that promote safe, healthy environments for all humans, and diffusion of innovation theory (DOI) (Wani & Ali, 2015). The cradle-to-grave model promotes circular construction practices that select materials that cause the least environmental harm. Wani and Ali (2015) state that the Diffusion of Innovation Theory (DOI) is grounded in well-established sociological, psychological, and communication theories. In addition, diffusion is the process by which innovation is communicated over time through specific channels among members of a social group. Further, the construction industry differs from other industries in that innovation depends upon adoption or implementation and problem-solving based on organisational learning.

Four critical aspects make up DOI: innovation, communication channels, time, and social systems, through a five-stage innovation process comprising knowledge, persuasion, decision, implementation, and confirmation (Tran et al., 2020). Unfortunately, the project-based nature of the industry, short-term relationships, and decentralised organisational structures do not foster learning, meaning the adoption of innovation is evaluated in the same context as individuals rather than through scientific studies (Wani and Ali, 2015). Tran et al. (2020) note that under the DOI, external social and political contexts are critical factors influencing the adoption of innovation, including sustainable materials. To achieve sustainable building by-laws, there must be a cooperative effort amongst interrelated units, including developers, designers, contractors, subcontractors, suppliers, government, and users or clients.

The contributions of the theories to the adoption of sustainable construction materials are expanded in the next section. The importance of materials that reduce harm to humans and the environment is promoted, with a focus on how regulatory frameworks like the MBBLs can be used to integrate and promote their inclusion.

2.2. Modern building by-laws for the adoption of sustainable construction materials

Among the planning tools, including development plans, town planning schemes, and building by-laws, the building by-laws are the most effective in shaping the built environment and achieving sustainable development (Chirisa, 2014). Regulatory barriers that prevent the adoption of sustainable materials are also prevalent in developed countries, resulting from unsuitable and non-comprehensive by-laws (Hoxha & Lecaj, 2024). Although Mogaji et al. (2024b) identified the importance of government regulations in advancing the adoption of innovative building materials, the authors did not offer any replicable implementation model. As such, including sustainability in the by-laws without specifying conformity guidelines for sustainable materials does not motivate their adoption in construction practice but ends at an experimental level. In Zimbabwe, the Ministry of Local Government and Housing published the Model Building By-laws in 1977 under the Urban Councils Act, Chapter 214, section 183, and Section 83A of the Rural Councils Act (Chirisa, 2014). The document covers structural design, foundations, masonry, walling, and construction of miscellaneous materials. These include that building by-laws often contain clauses that do not enable the adoption and implementation of sustainable construction materials. In addition, there is also a general need for more regulatory testing and inspection requirements for sustainable construction to ensure law enforcement. Also, green labelling of building materials, green building technologies and sustainable buildings where they have been applied is critical.

Including labelling in the drafting of by-laws will make it easier for consumers to identify sustainable products and technologies. Noted deficiencies in the existing Model building by-laws include the absence of sustainable construction materials, the rigidity of the by-laws, a lack of alternatives to traditional materials, insufficient information on the sustainability of included materials, and inadequate references to sustainable design. Chirisa (2014) identified critical inadequacies in the current model-building by-laws. Further literature on the use of sustainable construction materials includes Zami (2014), Mafuku (2019), and Kativu et al. (2023). Zami (2014) bemoans the lack of adequate regulatory mechanisms to drive the adoption of stabilised earth construction to alleviate the housing crisis. The author emphasises a lack of drive to implement the successfully tested stabilised earth construction for urban houses. Aligning with this, Mafuku (2019) laments the slow adoption of green construction in Zimbabwe, which promotes the use of green construction materials. In this regard, Kativu et al. (2023) highlight the contribution of poor regulatory frameworks to inadequate construction material waste management. This is particularly significant, as it exposes the extent of existing construction material waste management and the need to utilise sustainable construction materials.

However, these anomalies are not peculiar to Zimbabwe. In Kosovo, it was noted that spatial planning laws were silent on goals such as sustainable design, cities, infrastructure, and construction to ensure rational economic use of land (Hoxha & Lecaj, 2024). This is similar to what Chirisa (2014) identified. Fini and Akbarnezhad (2019) support the promotion of responsible procurement of materials by considering their economic, environmental and social impacts. However, this can only be achieved if the necessary technical support systems have been established and operationalised. Unfortunately, the Public Procurement and Disposal of Public Assets Act [Cap 22:2] fails to achieve this objective (Sakutemba et al., 2024). In addition, Nasier (2021) argues that the major constraint is that the selection of sustainable construction material must be practical, specific and aligned with budget needs. Again, practicality speaks to availability, which the construction material supply value chain fails to ensure (Sakutemba et al., 2024). Hoxha & Lecaj (2024) highlight constraints concerning by-laws that align with Mogaji et al. (2024a)'s findings regarding a lack of awareness and knowledge, as well as a lack of end-user involvement. As such, Kylili (2017) advocates increased use of sustainable construction materials by promoting well-supported policies. This also means that materials are to be labelled not only on their structural or mechanical performance but also on their energy performance, carbon footprint, health effects, thermal performance, indoor comfort, and environmental effects. To ensure the enforcement of labelled materials in practice, by-laws should include tax levies and provide end-user information on labelled materials (Hoxha & Lecaj, 2024). Smith (2015) notes that various international rating systems, such as BREEAM (UK and Europe), LEED (USA), GBAS (China), DGNB (Germany), and Green Star Australia, have been developed to promote sustainable construction. In addition, to promote localised sustainability standards, the Ministry of New and Renewable Energy established the Green Rating for Integrated Habitat Assessment (GRIHA) as the mandatory certification system for government buildings (Smith, 2015). In India, the Model Building By-laws (2016) require buildings on plots over 100 m2 to comply with green norms using LEED and GRIHA, emphasising renewable, prefabricated, or recycled materials and encouraging the use of locally sourced resources to reduce transport impacts (Singh and Kumar, 2023). The reviewed literature examines the model by-laws' exclusion of sustainable construction materials in developed and developing countries, as well as the contributions of scholars from those contexts.

3. Research Methodology

This study adopted an interpretive philosophy and a

qualitative research design to review the model-building by-laws for incorporating sustainable construction material utilisation in Zimbabwe, similar to Hoxha and Lecaj's (2024) study. This philosophy is focused on understanding the meanings people attach to their experiences, rather than measuring or predicting phenomena. It assumes that reality is socially constructed, that knowledge is co-created between researchers and participants, and that values and context influence all interpretations (Lee et al., 2023; Crowther & Thomson, 2020). The collected data were inductively utilised to build themes and patterns (Saunders et al., 2016). A qualitative methodological approach was used to collect data through narrative inquiry, aligned with participants' opinions and experiences (Leedy and Ormrod, 2013). A cross-sectional time horizon is selected when answering a question or solving a problem that requires collecting data within a specific time frame. Time horizons determine whether the study is a snapshot in time or a series of event representations over a given period (Saunders et al., 2016).

As supported by Babbie and Mouton (2015), this empirical research was grounded in the collection of primary data through semi-structured online interviews. The online interviews lasted no more than 60 minutes and were recorded after participants provided consent. An outsourced professional transcribed the audio, and member checking was conducted to confirm the data's validity. The interview guide consisted of demographic questions and questions that asked participants to offer their opinions on critical ways to incorporate sustainable construction material utilisation.

The researcher applied purposive sampling (Saunders et al., 2016) to solicit views from an equal representation of at most five local authorities or government officials, five researchers, and five green building or five construction professionals, as these were individuals with known or demonstrable experience and expertise in the area, spanning at least 3 years. Participants were sought from across the country through targeted outreach to universities, organisations, and professionals who had participated in sustainable construction-related research and projects. This information is available on the universities' or organisations' websites and local authority registers. The basics of this technique include all opinions or views; therefore, representation was not about proportions but about views or ideas. The critical aspect of this technique is to engage multiple consultants rather than a single consultant to achieve diversity through concept mapping. According to Saunders et al (2016) and Hennink et al. (2017), a minimum of four and a maximum of 24 interviews are deemed sufficient for an exploratory study. In addition, interviews must be done until saturation is achieved. While the study targeted at least five interviewees, interviews were conducted till saturation was achieved, that is, when no additional information on the objective was forthcoming. To achieve this, 20 potential interviewees were requested to participate. Interviews were conducted over 90 days at different times and in different settings, with interviewees from various backgrounds, thereby increasing the reliability of the results. The reliability of the qualitative data was enhanced using ATLAS.ti (version 25.0.1) and two independent coders, ensuring consistency and transparency in data interpretation. As Saunders et al. (2016) emphasise, reliability in qualitative data analysis depends on coders adhering to clear, replicable coding guidelines and working independently. In addition, the percentage of agreement was 95%, which was >80%, and this was accurate for a few categories (Bolognesi, Pilgram & Van der Heerik, 2016). Disagreements (5%) were minimal and resolved through coders' consensus and reference to the existing literature.

Data analysis was done using thematic analysis, a systematic qualitative method for identifying, organising, and offering insight into themes or meaning patterns across a dataset. This approach enables researchers to capture both explicit and underlying themes that reflect participants' experiences and perspectives (Braun and Clarke, 2022). The process involved familiarising with data associated with modifications to the Model building by-laws, coding interesting interventions of the data, generating a category from the codes and a theme map, defining themes, and finally producing the report relating to the research question and literature (Vaismoradi, 2013). Codes were developed deductively from existing literature. The codes were used to build categories by considering their relationships. The same categories were then used to build the themes, which were agreed upon by the coders.

To promote the research's aims in knowledge, truth, and error avoidance by prohibiting fabrication, falsification, or misrepresentation of research data, ethical considerations were implemented in the study, as supported by Resnik (2020). Ethics are norms for conduct that distinguish between acceptable and unacceptable behaviour (Saunders et al., 2016). Ethics approval was sought and approval granted for a low-risk study by the Department of Construction Management at the National University of Science and Technology in Zimbabwe. The researcher was responsible for protecting the respondents' rights during the research. Permission to conduct research was sought from respondents before engaging them. The researcher informed respondents before the interviews of how the information would be used. Ethical guidelines regarding informed consent, confidentiality, and anonymity were adhered to. Respondents were informed of the study's purpose and invited to participate, with no one required to participate under

duress. Scientific honesty was observed by refraining from any dishonest conduct, such as manipulating research methods and data or retaining data.

4. Findings and Discussion

This section considered the profile of the respondents and the presentation and discussion of the generated themes and categories of the strategies for incorporating sustainable construction material utilisation in Zimbabwe.

4.1. Profile of respondents

Interview invitations were sent to 20 respondents, and 16 were successfully conducted via phone calls and virtual meeting platforms. According to Hennink et al. (2017), 16-24 interviews are adequate to achieve meaning saturation for an in-depth understanding of issues. This study achieved saturation after the 15th interview. The profile of the respondents is shown in Table 1. Regarding educational qualifications, the analysis shows that 75% of the respondents had postgraduate qualifications, whilst 25% had an Honours degree. In terms of experience, 31.25% had more than 20 years, followed by 16-20 years and 6-10 years, and only 6.25% had 0-5 years. The interviewees were largely in high-level management positions. The percentage distribution was ideal because there were diverse perspectives from diverse professional backgrounds, as Burton (2021) echoed.

Table 1: Demographic profile of respondents

Interviewee	Level of education	Experience	Organisation	Position
1	Bachelor's degree	8	Green Building Council	Chief Executive Officer
2	Master's degree	20	Scientific Research Centre	Chief Executive Officer
3	Professor	38	Research Consultancy firm	Chief Executive Officer
4	Master's Urban Planning	11	Architectural firm	Chief Executive Officer
5	Bachelor's degree in engineering	11	Architectural firm	Projects Manager
6	Master's: Energy Engineering	4	Research Consultancy firm	Environmental Engineering/Sustainability Consultant
7	Bachelor's degree	10	Non-profit community-based organisation.	Co-founder, project development/training
8	Master's in Architecture	7	Architectural firm	Energy and Sustainability Auditor
9	Professor of Urban and Regional Planning	17	University	Pro Vice-Chancellor, Academic Affairs
10	Professor of Architecture	40	Architectural firm	Principal Architect
11	PhD Construction Management	21	University	Dean
12	Masters of Architecture	15	Architectural firm	Principal Architect
13	MSc Water Resources Engineering and Management	19	Civil Engineering Firm	Manager
14	Masters of Architecture	15	Entrepreneur	Director
15	Masters of Architecture	9	Architectural Firm	Director
16	Bachelor's degree	10	Ministry of Local Government and Public Works	Acting Deputy Director, Architectural Services

4.2. Modifications to Zimbabwe's Modern Building By-Laws (MBBL)

Interview participants were requested to suggest ways to incorporate sustainable construction material utilisation into the local Model Building By-Laws to promote their adoption. The extracted themes are presented in Table 2.

Table 2: Results- Themes, categories and codes

Theme	Category	Codes
Generation of modern by-laws with relevant and sustainable material promotion.	• Align with modern construction practices.	• Flexibility • New construction methods/practices
	• Stakeholder engagement	• Local materials • Incentives
Design-related modifications	• Material-specific	• Emphasise performance • Testing • Carbon calculation
	• Strategic	• Guidelines for consultation • Exploration/ research
Adopt green building principles or methodologies.	• Green building principles	• Green building codes • Energy efficiency • Embodied carbon • Climate change resilient
	• Green building instruction	• Training • Green skills

The extracted themes included the position that the Model Building By-Laws (MBBLs) of 1977 were unsuitable and insufficient to achieve sustainable construction goals and required more comprehensive consultation. The contributions from interviewees revealed three (3) themes: the generation of modern by-laws with relevant and sustainable material promotion, design-related modifications, and the adoption of green building principles and methodologies. The cradle-to-grave model is foundational in shaping the themes of modern by-laws, with relevant and sustainable material promotion and the adoption of green building principles and methodologies. The themes emphasise the promotion of human safety and protection of the environment as espoused by the theory. On the other hand, the theory of diffusion of innovation is situated in the themes of design-related modifications and adoption of green building principles and methodologies. The themes emphasise innovation in sustainable material promotion and green building methodologies; the communication of green building principles and methodologies; the rate of adoption of the suggested interventions; how the social construct influences adoption; and the adopter categories. The theme and categories are discussed hereafter.

4.2.1. Generation of a modern MBBL with relevant, sustainable material promotion

There is consensus that the MBBL document does not align with modern-day construction practices. MBBL should address challenges that may not have existed when they were formulated in 1977. MBBLs must align with modern construction practices and enable continuous participant engagement in this regard. In addition, the by-laws must address the current concerns highlighted by Interviewees 2, 7, and 13.

Interviewee 2: *…… by-laws should speak to climate resilient infrastructure……*

Interviewee 7: *room for developers to use alternative sustainable materials in the approved plans.*

Interviewee 13: *Model Building By-Laws must be revised and modernised to adapt to current trends, standards and practices in the construction sector.*

The views of Interviewees 2 and 13 align with Hoxha and Lecaj (2024), who argue that planning laws must adapt to current trajectories of sustainability development. The added advantage is that the views emanate from a researcher and a construction professional. MBBLs must be dynamic and align with modern construction practices. However, the interviewees did not clarify how best to achieve this. Despite these assertions, caution must be taken when aligning with modern construction practices within developing countries, as the level of industrialisation is a significant factor in any consideration. This is alluded to by Mathiyazhagan et al. (2019) regarding the gap between the challenges and the capabilities of developing countries, such as Zimbabwe. MBBL should allow flexibility, as supported by Interviewee 7. Stakeholders must be allowed to incorporate new and better sustainable materials, as and when they enter the market. However, due diligence must not be secondary; the approval process must be swift, sound, and supported by adequate research and development. Respondents suggested that minimal bureaucratic processes and procedures should be included within an addendum for approval and adoption of sustainable materials. Implementation and reference to addenda are critical (Chirisa, 2014), but they may not be incorporated as standard operating procedures due to potential administrative challenges. Hence, such addenda must be well supported by progressive policies (Kylili, 2017).

Continuous stakeholder engagement is pertinent if the

by-laws are to remain relevant, as Interviewee 1, Interviewee 4, and Interviewee 8 argue. The green building and construction professionals reach a consensus on stakeholder engagement, as outlined hereafter.

Interviewee 1*: Include sustainable alternative local materials.*

Interviewee 4: *stakeholder engagements are important.*

Interviewee 8: *Firstly, they should be improved to reward sustainable practices to motivate developers and professionals.*

Stakeholder engagement promotes the adoption and acceptance of sustainable local materials, especially when incentives are provided to developers and professionals. Hoxha and Lecaj (2024) supported this notion by highlighting that, to ensure the enforcement of labelled materials in practice, by-laws should include tax levies and information for end users. The interviewees suggest a section within the MBBLs that stipulates rewards or incentives for sustainable practices to motivate developers and professionals. Despite the suggestion, it may be important to ensure that the construction material supply value chain is adequately resourced to meet the need for sustainable construction materials, as this is problematic in developing countries like Zimbabwe (Sakutemba et al., 2024). A recommendation for incentives within the by-laws was further suggested for designers and developers, as stated by Interviewee 12.

Interviewee 12: *In practice, the central issue around practice is compliance with regulations that are set. You need to go back to those regulations, not some annexure or deviation committee. Very few people know about these, and no one is willing to go through all that. Imagine spending three years trying to get your material approved. You will not have the money to build afterwards. Let us fix the regulations. It could be a carrot-and-stick approach: you do not have to force everyone, but you can say, "If you protect the environment, you get so many credits or tax rebates." Incentivise the adoption of sustainable materials. There is a need to deliberate at all levels throughout the building chain and to reduce energy demand by adopting sustainable construction materials.*

Still, such suggestions demand a multi-pronged approach that aligns all construction-related policies related to procurement, construction contract administration, environmental policy, and waste management. When this is achieved, stakeholders can be encouraged to incorporate sustainable construction materials in their day-to-day construction activities.

4.2.2. Design-related modifications

Within this theme, categories of material-specific and strategic modifications were extracted. The MBBL were deemed too prescriptive and needed to test and encourage new methods, thus allowing professionals to propose new materials for inclusion in standards and to enable embodied carbon calculation, as highlighted by Interviewees 10, 3 and 5.

Interviewee 10: *I find that the Model Building By-laws need to be more prescriptive on how to build. They should have standards that test and encourage new methods. I mean, architects should be allowed to propose new materials after proper testing for inclusion in standards and by-laws.*

Interviewee 3*: So, I think they need to drop the reference to cement altogether and just have things about performance. Can your material do this? Then you can do this with it.*

Interviewee 5: *Should include embodied carbon, which is measurable*

Design flexibility may be beneficial, as designers can add value by selecting alternative materials for their clients. This view is supported by Nasier (2021), who argued for practical material selections aligned with current sustainability practices. In addition, designers must be permitted to implement circular principles in their designs if the material's performance is guaranteed. This approach is reinforced by Singh and Kumar (2023) through their by-laws, which provide for reducing, reusing, and recycling to achieve zero landfills. For these suggestions to work, it is important that designers are given the freedom to develop better design codes that address existing concerns. This endeavour is more complex than it reads. It requires a concerted effort by tertiary institutions, industry, and research and development organisations to implement a well-regulated and flexible design regime, which can be onerous for a developing country like Zimbabwe. However, the idea can be initially implemented at a smaller scale and nurtured over time to realise the goals of sustainable construction material adoption.

The incorporation of design-related modifications must be strategic. Interviewees suggested that it be made mandatory for designers to incorporate sustainable building materials and promote buy-in from stakeholders. Conversely, flexibility is not supported by imposing "mandatory" inclinations on designers. However, this means guidelines must be developed and continually improved while consistent research and development are implemented. This is alluded to by Interviewees 6 and 13.

Interviewee 6: *Include guidelines for sustainable materials consultation in the MBBLs to encourage exploration, use as a reference, and include embodied carbon guidelines*

Interviewee 13: *Buy-in from all stakeholders. Increase funding for research in such construction technologies. Increase visibility and marketing of such products. Make sure such materials go through a standardisation process.*

However, the modifications can only be made after testing and approving sustainable materials and technologies. Fini and Akbarnezhad (2019) support such modifications if they are cognisant of the impacts of such sustainable material considerations. While this is true, the reality is that tested solutions, such as stabilised earth (Zami, 2014), have yet to be implemented, which further complicates regulatory frameworks and their modification for implementation. This will make it more difficult for construction industry researchers and professionals to recommend and construct using sustainable materials. Some interviewees emphasised that by-laws should address climate-resilient infrastructure and alternative materials, encouraging their exploration as addenda. This view came from researchers, who are more knowledgeable about the current challenges in the construction sector.

Notwithstanding this, the apparent gap between research and on-the-ground implementation must be reduced to enhance the development of practical solutions. Further suggestions included creating a sustainable construction policy to serve as a reference for the MBBL. Again, the reality is that design-related modifications require that all designers be conversant with sustainable construction before they can design sustainably.

4.2.3. The adoption of green building methodologies in MBBLs

This theme comprised the categories of green building principles and green building instruction. Some respondents recommended attention to green building principles, including interviewees 4 and 16.

Interviewee 4: *Speaking to energy efficiency in the MBBLs, working on affordable housing building guidelines, and providing them with carbon calculations.*

Interviewee 16: *A green building code may also be formulated, adopted and enforced as an addendum to the Model Building By-laws."*

This is significant, coming from a construction professional and a government official. It shows that the government recognises the importance of promoting green building principles. As suggested by Fini and Akbarnezhad (2019), considering the environmental impact of the material, such as carbon footprint analysis and energy efficiency, is pertinent. As such, energy efficiency is to be included in the MBBLs with accompanying embodied carbon calculations as a critical material performance criterion. However, the practicability of this is remote. Zimbabwe is not yet ready to implement green building and construction as alluded to by Mafuku (2019). If this is still the case, this suggestion would be difficult to implement. In addition, the failure to align procurement with the need to adopt sustainable construction materials is detrimental. In addition, other respondents felt that a chapter on sustainable design, with credits for using sustainable construction materials, was necessary, as reported by Interviewee 16. India's Model Building By-laws of 2016 include green building and sustainability provisions, including sections on applicability, sanction requirements, and various green rating system guidelines (Singh and Kumar, 2023). These by-laws are supported by adequate infrastructure to achieve them, which may not be relevant for Zimbabwe. In addition, Hoxha and Lecaj (2024) revealed that including sustainability in the by-laws without specifying conformity guidelines for sustainable materials would not motivate their adoption in construction practice, but would instead remain at an experimental level. Zami (2014) already confirmed this within the Zimbabwean context. Along with this, there were supposed to be affordable housing and public building guidelines that address the use of sustainable materials, so that the government leads from the front. Unfortunately, the comments from government officials expose their lack of readiness to implement this, despite the practice being supported by Hoxha and Lecaj (2024), who argue that the inclusion of green labelling in drafting by-laws makes it easier for consumers to identify sustainable products and technologies.

In green building instruction, the importance of training construction professionals in green building principles and technologies, and the need for research and standardisation of green building materials, are paramount. Interviewees 9 and 15 highlight the significance of training and skill sets. It is paramount that these comments are coming from an academic and a construction professional.

Interviewee 9: *Use existing policies and demo structures for training.*

Interviewee 15:*….needs skillset to calculate parameters…..*

Adequate technical support systems are essential if green building principles are to be adopted. Kylili (2017) and Mogaji et al (2024b) allude to the importance of supporting the implementation of green building technologies through enhancing awareness and encouraging competent standardisation processes for practical solutions. Inversely, Kativu et al. (2023) attribute the lack of adequate trainers and training to inadequate instruction on construction material waste management. This means the country needs to leverage

external partners to achieve adequate green building instruction. The importance of training building inspectorates in the application of sustainable construction materials through tertiary institutions and vocational colleges is also pertinent.

Cumulatively, emphasis was placed on the need for governments to lead implementation to build stakeholder confidence. Government projects needed to adhere to any alterations to the MBBL to ensure that state construction projects used sustainable construction materials. Along with this, there were supposed to be affordable housing and public building guidelines that addressed the use of sustainable materials, so that the government led from the front. This practice is supported by Hoxha and Lecaj (2024), who argue that the inclusion of green labelling in drafting by-laws makes it easier for consumers to identify sustainable products and technologies. Smith (2015) revealed that other developing countries, such as India, had adopted the green rating systems to promote the inclusion of sustainable materials. A green building code needs to be formulated, adopted, and enforced, and it should also be included as an addendum to the Model Building By-laws. Relative acts needed to be updated to include allowances for the use of natural resources, with provision for replenishment procedures within specific time intervals. For example, any regulations must be advanced by government departments as supported by Mogaji et al (2024a).

5. Conclusion and Further Research

The literature review and interviews indicated that the by-laws were limiting, to a large extent, the adoption of sustainable construction materials. As such, recommendations for generating modern MBBL with relevant, sustainable material promotion must be included in the key strategies. The other recommended modifications are design-related and involve adopting green building principles or methodologies in MBBLs. There was insistence that all modifications be made through extensive stakeholder consultation and participation to ensure buy-in to the regulations, which, in turn, would make implementation easier.

A comparison with the literature review supported these suggestions. However, the challenges peculiar to Zimbabwe limit the uptake of some of these recommendations, hindering Zimbabwe's progress in aligning with current global discussions, challenges,and trends. For example, design flexibility may contribute to a chaotic administrative process within local authorities.

The study contributed pertinent strategies that can be incorporated into the modification of the existing Model Building by-laws to drive the sustainable construction agenda. The study contributed key interventions aligned with the need to promote human and environmental safety (cradle-to-grave model) and promote innovation in the adoption of sustainable construction materials (diffusion of innovation). In particular, the study recommends that the Government of Zimbabwe should create a new and updated Model Building By-laws based on the use of sustainable or circular materials and developed through a thorough stakeholder participation programme that includes researchers, academics, construction professionals, and material suppliers, among others. The adoption of any innovations regarding sustainable construction materials must be founded on inclusive, well-established communication channels (through the various construction-related policies, including the MBBLs), be timeously responded to, and have a positive impact on existing social systems (cultural systems that influence the design and use of construction materials). The generation of practical interventions is supported, while the modification of construction-related policies is identified as fundamental to achieving the integration of sustainable construction materials. A comprehensive stakeholder-initiated review of the existing Model building by-laws that align with holistic sustainability goals is recommended. Further studies can examine piloting the implementation of a revised by-law chapter in a selected municipality or conducting a quantitative assessment of developers' willingness to adopt labelled materials under various incentive schemes. The main limitation was the exclusive use of a key-informant qualitative design rather than end users. However, the exploratory nature of the study supported the approach.

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