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The Strategies of the Use of Green Building Materials Effectively among Contractor in Construction Industry

Lee Chui Wei[1], Seow Ta Wee[1,2]*, Norliana Sarpin[1,2], Haryati Shafii[1,2]

[1] *Department of Construction Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat 86400, Johor, MALAYSIA*
[2] *Centre of Sustainable Infrastructure and Environmental Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat 86400, Johor, MALAYSIA*

*Corresponding Author: tawee@uthm.edu.my
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Abstract

This research addresses the environmental and health implications of traditional building materials, such as concrete and lead-based paint. Despite the adoption of green building materials, health issues persist, necessitating effective strategies. The study, focused on Johor Bahru, aims to enhance well-being by exploring factors influencing the use of green materials and proposing strategies for their effective implementation among grade 7 contractors. Methodologically, a quantitative approach involved a sample of 135 contractors through a Google Forms survey. Statistical analyses, including ANOVA, revealed non-significant age and education effects but significant racial ($p < 0.001$) and experience ($p < 0.05$) impacts on perceptions of green materials. There are highly significant differences among racial groups ($p < 0.001$), emphasizing their substantial contribution to variations in factors and strategies. In contrast, education levels showed non-significant variations ($p > 0.05$), suggesting a lesser role in shaping contractors' views in this context. Key findings suggest a consensus on the positive impact of green materials on worker health, indoor air quality, and reduced health incidents. The discussion emphasizes the importance of prioritizing safety, training, and regulatory support. Future work recommendations include assessing the long-term effects of emerging green materials and optimizing their cost-effectiveness and scalability. The study provides vital insights for sustainable and healthy construction.

1. Introduction

Materials such as vinyl, sisal, nylon, cotton, and wool can be used to create green building supplies. These materials are generated and utilized in sufficient quantities without depleting the available nonrenewable resources or upsetting the environmental equilibrium (Kharwar, Saroj, Marwein, Paul, and Singh, 2021). The application of eco-friendly, healthy building materials can enhance indoor air quality and reduce the risk of exposure to hazardous and noxious substances (Maleknia, Parcsi, and Stuetz, 2014).

1.1 Research Background

Traditional building materials, such as concrete, steel, and wood, have been linked to an array of adverse environmental and health effects (Gupta *et al.*, 2019). In addition to their negative effects on the environment, traditional building materials can also pose health hazards to building occupants. Asbestos, a prevalent building material until the 1970s, has been associated with respiratory diseases and cancer (Berman & Crump, 2008).

Additionally, lead-based paint, which was prohibited in the United States in 1978, poses health risks, especially to children (Landrigan *et al*., 2002). In light of these negative effects, there is a growing demand for environmentally friendly building materials. Green materials are those that impose the least environmental burden on the planet and are good to human health throughout the stages of raw material adoption, product production, usage or recycling, and waste disposal (Breeze and Vaidya, 2021).

1.2 Problem Statements

The lack of appropriate approaches from responsible units has perpetuated the problem of toxic compounds in traditional building materials, making its resolution difficult (Kai and Zeng, 2022). Published 2019 Studies have shown that hazardous and toxic substances hidden in building materials pose dangers to health and safety, disturbing the environment and affecting the projects' turnover (Journal, Chia, and Su, 2019). However, after Malaysia began to use green building material, the health problems caused by traditional building materials still exist, and because many people still don't know why they use green building material, effective strategies for using green building material are needed, which is also the purpose of this study. Traditional building materials can have adverse effects on human health, particularly when they contain hazardous substances such as lead-based compounds, asbestos, and formaldehyde. These substances can cause a wide range of health problems, including respiratory illnesses, cancer, and neurological damage (Joseph, 2020). Traditional building materials such as asbestos and lead-based paint pose significant health risks, especially for construction workers and occupants of older buildings (Goh, K., 2019). In contrast, green building materials are frequently selected due to their minimal toxicity and ability to promote good indoor air quality, which can result in improved occupant health and productivity. By utilizing green building materials (Marwa and Zeyad, 2021). Traditional paints contain significant concentrations of hazardous volatile organic compounds (VOCs). VOCs can cause respiratory issues, migraines, nausea, and additional health problems. These detrimental chemicals are reduced in low-VOC paints, making them a safer alternative (Ahmed, Ali and Mona, 2021).

1.3 Research Question

The research question are as follows;

i. What are the motivations the use of green building materials in construction projects in the role of health concerns?
ii. In terms of health concerns, how effectively do contractors use green building materials in construction projects?

1.4 Research Objectives

The research objectives are as follows;

i. To identify the factors influencing the use of green building materials in construction projects in the role of health concerns.
ii. To suggest the strategy for using green building materials effectively among contractors in the role of health concerns.

1.5 Scope of the Study

By focusing on Johor Bahru, the author aims to contribute to the development of a sustainable and healthier living environment for the citizens of this city, through collecting information through contractors with grade 7 in Johor Bahru thereby enhancing their well-being. Due to their involvement in project design, specification, and delivery system, contractors' knowledge and appreciation of green building index assessment instruments are crucial for assuring the achievement of the development of green buildings. Contractors in Johor have ranked sustainable site as the most important criteria in GBI with a weighting scale of 0.176. Johor Bahru is an ideal location to investigate the integration of green building materials in a developing urban environment due to its rapid urbanisation and development.

1.6 Significance of the Study

The importance of research are as follows;

1.6.1 Suggesting Practical Green Building Material for Developers

By analysing the factors that influence the use of green building materials, developers can consider foam glass, green walls, ecological cement, green concrete wall-building composite materials, and recycled materials as practical green building materials.

1.6.2 Developing a Healthy Residential Environment for Residents

A healthy community ensures that its residents have access to secure, decent, and affordable housing that promotes their health. Unhealthy homes can increase the incidence of asthma, respiratory and skin allergies, and pulmonary diseases, among others. Unhealthy homes impair mental and social well-being, such as depression, isolation, stress, and behavioural abnormalities.

1.6.3 Enhanced Contractor Labour Safety

This can enhance worker safety by reducing the likelihood of accidents, injuries, and strain-related issues. Reduced workers' compensation claims and improved overall productivity are advantageous for contractors.

1.6.4 Regulatory Conformity for Contractors

By utilising green construction supplies, contractors can ensure compliance with these regulations, thus preventing possible fines or delays in project approvals. This compliance can assist contractors in establishing a favourable reputation and gaining access to government incentives and green building certification programmes.

1.6.5 Demand in the Market and Competitive Edge for Contractors

By incorporating sustainable building materials into their projects, contractors can attract environmentally conscious clients and obtain a market. This can result in more project opportunities and increased profitability.

1.6.6 Ensuring Environmental Rights

Due to the absence of environmental governance, which includes insufficient environmental provisions, insufficient penal provisions, a lack of resources, ignorance, and short-term planning, the extant legal mechanisms are not conducive to the environment and development. In order to administer a pure and healthy environment towards sustainable development in Malaysia, it is crucial to protect environmental rights.

1.6.7 Building a Market-oriented Green Technology Innovation System that is Important for Sustainable Development

Adopting more green consumption subsidy policies, enhancing the supervision mechanism, and formulating more incentive policies, among other policy implications, will be beneficial.

2. Literature Review

Implementing green building material practises has been identified as a means to reduce risks to human health and promote sustainability in the construction industry. The use of green building materials is one of the strategies employed in health care, and it is becoming increasingly important to adapt to future sustainability trends (Puteri, Tharim, Ahmad, and Rozana, 2022). This literature review seeks to suggest strategies for the use of green building materials in the construction industry.

2.1 Factors Influencing the Use of Green Building Materials in Construction Projects in the Terms of Health Concerns

There are several health concerns related to the use of green building materials in construction endeavors. Here are some relevant factors:

2.1.1 The Use of Green Building Materials Improves Air Quality

By lowering the presence of harmful pollutants, green building materials can enhance indoor air quality. Typically, materials with low or no volatile organic compounds (VOCs), such as low-emitting paints, adhesives, and sealants, are chosen to reduce the health hazards associated with poor indoor air quality. Concerns about allergies and respiratory problems may have an impact on the demand for healthier indoor environments (C. Yu, 2014).

2.1.2 The Use of Green Building Materials Can Significantly Reduce Health Risks for Construction Workers

The use of green building materials can help reduce exposure to these toxic substances. Green building materials aim to minimise the use of hazardous substances like formaldehyde, lead, asbestos, and other toxic compounds (S. TheiBen, J. Hoper, M. Lambertz, A. Hollberg, H. Konig, and P. Hollberg, 2022). There are several uses of green building material related to the reduce exposure to the toxic substance. Here are some relevant green building materials:

i. Low-emitting Flooring (Corrine, 2021).
ii. Low-VOC Carpeting
iii. Moisture-resistant Gypsum Board, Water-resistant Coatings, and Mold-inhibiting Materials (Jill, Sherry, David, Jorge, and William, 2015).
iv. Formaldehyde-Free Insulation (Liu, Sharples, and Mohammad, 2021).
v. Green Roofing (Niu, Clark, Zhou, and Adriaens, 2010).
vi. Tannin-based adhesives (Patel, Toliwal, and Patel, 2012).

2.1.3 Regulatory and Certification Requirements

The Malaysian government has established regulations and standards governing the use of building materials to guarantee their safety and minimise health risks (A. Olanrewaju and A. Idrus, 2019). These regulations limit the levels of hazardous substances permitted in building materials, such as lead and formaldehyde (Irina, Rahmalan, Krishna, and Wahid, 2013).

2.1.4 Enhance thermal convenience

Green building materials can enhance thermal comfort by regulating temperature and humidity levels, which has a positive effect on human health by reducing the risk of heat stroke, hypothermia, and other temperature-related health problems (Salwa, 2019).

2.1.5 Noise Pollution Reduction

By absorbing sound and reducing the amount of noise that penetrates a building, green building materials can play a substantial role in reducing noise pollution (Renterghem, 2018).

2.1.6 Proper Ventilation and Air Quality Control in the Context of Green Building Materials

The rising popularity of green building materials is attributed to their capacity to reduce environmental and human health consequences. However, it is important to ensure sufficient ventilation and maintain air quality when dealing with these chemicals in order to minimise potential health hazards. Proper ventilation not only improves the quality of the air indoors but also guarantees the health and safety of both construction workers and future occupants (Seyed, Rosli, Dalia, Abbas, and Ismail).

2.1.7 Prioritizing Workers' Safety and Health in the Selection of Construction Materials

The utmost significance of giving top priority to the safety and well-being of workers when choosing construction materials. Their research clarifies that green building materials are selected not only for their environmental characteristics, but also for their ability to reduce health risks to the workforce. This diligent approach demonstrates a dedication to establishing a safe working environment, in accordance with the moral obligation to protect the welfare of workers engaged in construction tasks (Lee & Wang, 2017).

2.1.8 Essential Training Programs for Safe Handling of Green Building Materials for Construction Teams

Training programmes that focus on the correct use of green building materials are crucial for construction teams to address health concerns and promote a construction environment that emphasises well-being and safety. Utilising green building materials, such as plant fibres and bio composites, offers a chance to mitigate environmental and human health consequences in construction endeavours. Construction teams, when possessing the necessary expertise, actively contribute to fostering a construction environment that prioritises health and well-being (Chen, 2021).

2.1.9 Influence of Awareness Regarding Health Risks on the Accelerated Adoption of Green Building Materials

The increasing awareness of health hazards linked to conventional construction materials has accelerated the acceptance of eco-friendly alternatives in the construction sector. Stakeholders are inclined to transition to eco-friendly alternatives because of the potential adverse health effects associated with conventional materials. Having this awareness is an essential element in the transition towards selecting materials that prioritise health, showcasing a proactive stance in mitigating health hazards (Wong and Liu, 2023).

2.1.10 Necessity for Industry-Wide Research on Health Impacts of Different Building Materials

The main objective is to prioritise research efforts in the construction industry, with a specific focus on clarifying the health effects of different building materials. Their research indicates that thorough empirical investigations are essential for understanding the intricate health dynamics related to both conventional and environmentally-friendly construction materials. The industry-wide research initiatives are crucial for enhancing the collective knowledge base. These initiatives inform the careful selection of materials and improve construction practices that prioritise health (Huang and Li, 2016).

2.1.11 Strategic Integration of Health Considerations into Green Building Material Selection

The construction industry must prioritize health and environmental protection in their decision-making processes when selecting green building materials. This includes considering factors such as the impact of materials on indoor air quality, thermal comfort, and overall health (Kuei-Yang, Wu, Tsai, Yung, 2013).

2.1.12 Correlation Between the Prioritization of Green Materials and Reduction in Health Incidents

Utilising eco-friendly construction materials in building projects has demonstrated a beneficial influence on both health and safety. Plant fibres, which are considered green construction materials, are receiving increasing recognition due to their ability to improve the mechanical characteristics of composites. As a result, they are becoming more suited for a wide range of civil engineering applications (Nasir, Waqas, Kaffayatullah, and Ayaz, 2022).

2.2 The Strategy for Using Green Building Materials Effectively among Contractors in the Terms of Health Concerns

There are several strategies for using of green building materials in construction among contractors in the role of health concerns. Here are some relevant strategies:

2.2.1 The Government Should Focus its Incentives on Projects that Prioritise Environmentally Friendly materials with a Strong Emphasis on Promoting Health

These incentives can include tax exemptions, grants, or other financial rewards designed to encourage compliance with predetermined health and environmental standards. This approach guarantees that economic incentives align with the necessity of prioritizing both environmental sustainability and health considerations in the construction industry (Smith, 2020). Targeted government incentives can have a substantial influence on sustainable construction practices. Studies indicate that government incentives, such as tax exemptions, subsidies, and financial incentives, specifically designed to encourage the use of environmentally-friendly materials, can successfully encourage a significant change in contractor behavior (Kramat Hussain, Zhen He, Naveed Ahmad, Muzaffar Iqbal, Muhammad Zubair Saeed, 2022).

2.2.2 Contractors Should Actively Seek Feedback from Workers Regarding Health Concerns Related to Materials

Contractors should actively seek and implement feedback from their workers in order to responsibly manage occupational health. Creating channels for transparent communication, such as regular forums or anonymous suggestion systems, helps gather diverse viewpoints on health issues related to construction materials. This iterative feedback loop provides information that guides the careful selection of materials, ensuring that green building materials are chosen in a way that meets both the goals of environmental sustainability and the well-being of workers (Jones *et al*., 2018).

2.2.3 Promote Teamwork by Forming Inter-disciplinary Collaborations

Green building programmers such as LEED and Enterprise Green Communities provide contractors, architects, and constructors with useful tools for incorporating healthy materials (S. Hoell, 2017). Foster collaboration by establishing inter-disciplinary partnerships, sharing knowledge and resources, and involving stakeholders in order to effectively use green building materials. This can result in more innovative and sustainable building designs

that benefit the environment and human health (M. Samer, 2013). Effective planning and design by contractors, architects, and builders will facilitate the incorporation of healthy construction materials. It should include effective planning and design strategies, personal safety issues and ecological plans, green building materials, appropriate and reliable technology, interdisciplinary collaboration, and research on green building materials. (E. Mussinelli, 2021).

2.2.4 Effective Communication Among Project Stakeholders Regarding Health Considerations is Crucial

Regular interactions with stakeholders, providing project updates, and thorough documentation are effective means of sharing information about material choices, associated health risks, and necessary safety measures. A culture of open and honest communication creates a collaborative environment where all stakeholders collectively support the principles of health-conscious construction practices (Brown and Johnson, 2017).

2.2.5 Contractors Should Provide Comprehensive Training on the Health Benefits of Using Green Building Materials

In order to optimize the health advantages of green building materials, it is essential to give utmost importance to comprehensive training programs that educate construction personnel about these benefits. Several crucial elements of these training programs may comprise:

2.2.6 The Development of Safety Protocols and Guidelines for Working with Green Building Materials is Essential

The process of codification is essential for reducing possible risks and health hazards, and for safeguarding the welfare of construction workers and the overall ecological environment (Kai Cao, Zhipeng Zeng, 2022).

2.2.7 Green Building Material Selection Should Prioritize Materials with Proven Health Benefits

Contractors are required to meticulously analyze scientific literature, validate assertions, and priorities materials that not only promote environmental sustainability but also unequivocally improve the health and well-being of occupants (Matar, Atiyat, & Abu Ameereh, 2015; Kieu & Schäfer, 2020).

2.2.8 Regular Health Assessments of Construction Workers Should be Conducted on Projects Using Green Materials

Frequent health evaluations of construction workers are crucial, particularly when dealing with eco-friendly construction materials. Green building materials are specifically engineered to minimize their ecological footprint and safeguard human well-being. Nevertheless, it is crucial to guarantee that the workers responsible for managing these substances are not subjected to any conceivable health hazards (Kai Cao, Zhipeng Zeng, 2022).

2.2.9 Contractors Should Invest in Protective Equipment and Tools Designed for Safe Use with Green Materials

Investing strategically in specialized protective equipment designed specifically for safely handling green building materials is a concrete demonstration of the dedication to occupational health and safety in the construction industry (M. Ghafori, 2019). This involves the acquisition and distribution of respiratory protection, gloves, and additional equipment specifically designed to reduce the inherent risks associated with the handling of sustainable construction materials (W. Taemthong, N. Chaisaard, 2019).

2.2.10 Promotion of Best Practices by Industry Associations

Industry associations can actively advocate for best practices to encourage contractors to adopt green building materials. This entails the development and distribution of guidelines, coordination of instructional sessions, and facilitation of knowledge exchange forums among contractors. Industry associations promote and encourage these practices, leading to increased awareness and widespread adoption of health-conscious approaches in the construction industry. (Nugradi, 2021).

3. Research Methodology

This study's methodology consisted of five stages, here are five relevant stages: (Refer to Figure 5 in Appendix A)

3.1 Research Design

This research was completed through a combination of quantitative method, primary data collection, and secondary data analysis. The author's specific scope of respondent requirements includes contractors with a grade 7, local operation, and compliance with the conditions of validity regarding their building category and overall validity status. Based on the findings, the author has determined that there are 530 registered contractors in Johor Bahru, including both companies and individuals.
Using the value closest to 530 population size in the Krejcie and Morgan table, which is number of 550. According to the Krejcie and Morgan method, the author has determined that 226 respondents constitute an adequate sample size for the study. This sample size is determined by a population of 530 people. The Krejcie and Morgan method provides guidelines for calculating the sample size necessary to attain a specified level of confidence in the population's representation. After the author had determined that 226 respondents' sample size was adequate for the study (refer to Figure 6 in Appendix A), The survey was completed, and a total of 135 respondents answered.

3.2 Data Collection

For the convenience of participants, the Google Forms questionnaire will be distributed via multiple channels, including Facebook, WeChat, WhatsApp, and email. Participants will have access to the questionnaire at their discretion, will be able to complete it online, and will be able to submit their responses. Once the Google Forms survey data has been collected, it will be available for analysis. (Refer to Figure 7 in Appendix A)

3.3 Data Analysis

For the numerical responses obtained, statistical methods will be applied using SPSS (Statistical Product and Service Solutions). This entails calculating frequencies, percentages, and averages to provide a quantitative overview of the dataset. Moreover, the application of t-tests and ANOVA will be instrumental in exploring variations and potential group differences within the numerical data. Concurrently, the free-text responses will undergo qualitative analysis to identify recurring themes. The author will meticulously review and categorize each respondent's answers based on the developed classification system.

4. Result and Discussion

The following data for the hypothesis demography category is in the factors and strategies group:

4.1 Introduction

Section 4 serves as an exhaustive synthesis of the gathered data, providing an in-depth analysis of the research objectives. The subsequent dialogues offer an in-depth understanding of the intricacies pertaining to the construction sector in Johor Bahru, particularly concerning the utilization of environmentally friendly building materials and the resulting health impacts. Through this exploration, the chapter aims to contribute valuable insights to the broader discourse on sustainable construction practices and effective utilization strategies among contractors.

4.2 Discussion of the Factors Influencing the Use of Green Building Materials in Construction Projects in the Terms of Health Concerns

Table 2 in Appendix A presents statistical insights into the discussion of factors influencing the use of green building materials in construction projects, with a specific focus on health concerns. The table includes key indicators such as the number of valid responses (N), means, medians, modes, standard deviations, variances, and sums. It highlights aspects like the positive impact of green materials on construction workers' health, improved indoor air quality, and the correlation between prioritizing green materials and reduced health incidents. (Refer to Table 2 in Appendix A). Following looked at the detailed statistical analysis in Table 1 in Appendix A which summarises key metrics, the talk then moves on to different aspects of what makes people choose green building materials for construction projects, with a focus on health issues. The following paragraphs go into more detail about each point:

i. Avoiding Dangers to the Health of Employees

There is a consensus among all respondents, as shown by the mean score of 4.10 and the median score of 4.00, that the use of environmentally friendly building materials significantly lessens the risks to the health of construction workers. That respondents have a rather constant interpretation, lends credence to the idea that

there is a fundamental tendency towards this positive evaluation, which is reinforced by the mode of four. It was revealed that the use of environmentally friendly building materials significantly reduces the health risks that are posed to construction workers (C. Yu, 2014).

ii. Improvements Made to the Air Quality Inside

There is a strong consensus about the substantial influence that environmentally friendly materials have on the improvement of indoor air quality, as shown by a mean score of 4.21 and a median score of 4.00. A moderate standard deviation, which demonstrates that participants have a common understanding, lends credence to the general agreement that is supported by the mode of four. Green materials provide a significant contribution to the improvement of indoor air quality by reducing the amount of harmful chemicals that are often found in conventional building materials (Sonja N. Sax and A. Lewis, 2012).

iii. Less incidences of health problems

A significant number of people believe that giving priority to environmentally friendly materials is associated with a reduction in the number of health-related incidents that occur during construction projects, as shown by the mean score of 4.16 and the median score of 4.00. In addition to providing support for this viewpoint, the mode of four is backed by a tiny standard deviation, which demonstrates that respondents are in constant agreement with one another (S. TheiBen, J. Hoper, M. Lambertz, A. Hollberg, H. Konig, and P. Hollberg, 2022).

iv. Gaining an Understanding of the Health Benefits

There is a strong consensus among construction professionals about the understanding of potential health benefits associated with green building materials, as shown by a mean score of 4.25 and a median score of 4.00 by the survey. Indicating that respondents have a consistent grasp of the topic, the mode of 5 suggests that there is a general positive perspective that is supported by a tiny standard deviation. There is a high level of agreement among construction experts on the potential health benefits associated with environmentally friendly building materials (Irina, Rahmalan, Krishna, and Wahid, 2013).

v. Ventilation and Quality Assurance and Control

When it comes to the utilisation of environmentally friendly building materials, a mean score of 4.27 and a median score of 4.00 indicate a high level of agreement which highlights the need of quality control and adequate ventilation. Having a median of five lends credence to this viewpoint, and the fact that the standard deviation is quite low demonstrates that respondents had a consistent perception. While working with environmentally friendly building materials, the importance of the requirement for adequate ventilation and quality control was brought to light, highlighting the worth of these factors in the process of preserving healthy indoor environments (Marwa M. Gomaa Mayhoub, Mona G. Ibrahim, Zeyad M. Tarek El Sayek, and Ahmed Abdel, 2019).

vi. Putting the safety of workers first is a priority.

As shown by a mean score of 4.25 and a median score of 4.00, there is a consensus that the safety and health of workers need to be the first consideration when selecting construction materials. A relatively low standard deviation reflects a consistent attitude among respondents, highlighting the relevance of emphasising worker safety. The mode of five underlines the prevailing position, and both of these factors contribute to the fact that the mode is 5. When it comes to selecting construction materials, the notion highlights the universal consensus that it is essential to put the safety and health of workers first (Scott Earnest, 2021).

vii. Programmes of Training That Are Requirements

Training courses on the safe use of environmentally friendly building materials are seen to be of utmost importance for construction workers, as shown by the mean score of 4.24 and the median score of 4.00. It is clear that respondents are in agreement with the significance of such training courses, as shown by the moderate standard deviation and the mean of 5, which is five. It is widely acknowledged that construction teams must have access to training courses that concentrate on the safe use of environmentally friendly building materials (Earnest *et al*., 2021).

viii. There is a correlation between awareness and adoption.

There is a consensus among respondents, as shown by the mean score of 4.11 and the median score of 4.00, that the adoption of environmentally friendly goods is influenced by the understanding of health issues associated with traditional construction materials. This viewpoint is supported by the fact that the mode is four, and the fact that the standard deviation is little suggests that respondents have a consistent understanding of the function that knowledge plays in the acceptance of content. The health risks associated with traditional construction materials has a significant impact on the adoption of environmentally friendly goods (Ahsen, 2023).

ix. Regulations and Guidelines for Assistance

With a mean score of 4.33 and a median score of 5.00, it is clear that there is a significant amount of support for regulatory agencies that provide guidelines for the secure use of environmentally friendly construction materials. This support is shown by the mean score of 5, and the fact that the standard deviation is quite low implies that respondents are generally in agreement with the notion that regulatory regulations are not only necessary but also essential. (Irina, Rahmalan A, Krishna G. R, and Wahid O, 2013).

x. Establishing research as a top priority

The construction industry should concentrate research on the health consequences of different building materials, according to the result of a survey that received a mean score of 4.16 and a median score of 4.00. It is clear that respondents had a consistent assessment of the usefulness of research in material choices, as shown by the moderate standard deviation and the mode of 4, which stresses this opinion. For the purpose of making better decisions on the materials that are used in construction, the explanation argues that there is consensus that the construction industry should prioritise research on the health impacts of different building materials (Mary Klett, 2021).

4.3 Discussion of the strategy for using green building materials effectively among contractors in the terms of health concerns

The Table 3 in Appendix A encapsulates essential information, including the number of valid responses (N), mean scores, and standard deviations, shedding light on various aspects such as training priorities, collaborative efforts, government incentives, safety protocols, and communication strategies within the construction industry. (Refer to Table 3 in Appendix A). Following looked at the detailed statistical analysis in Table 1 which summarises key metrics, the talk then moves on to different aspects of what makes people choose green building materials for construction projects, with a focus on health issues. The following paragraphs go into more detail about each point:

i. Training and Collaboration: Contractors unanimously recognize the importance of comprehensive training (mean score 4.08) and collaboration (mean score 4.20) for effective use of green building materials, indicating a shared commitment to health-conscious practices. This is in line with the advice given by Earnest *et al*. (2021), which emphasizes the need for continual education to ensure the safe use of ecologically friendly building materials.

ii. Government Incentives: The high mean score of 4.34 for government incentives demonstrates a strongly agreement among contractors that government support should specifically target projects prioritizing health-conscious green materials. This is consistent with the viewpoints presented by Irina, Rahmalan, Krishna, and Wahid (2013), which highlight the importance of external frameworks that promote safe utilization of environmentally friendly building materials.

iii. Safety Protocols: The mean score of 4.26 for the development of safety protocols highlights the industry's acknowledgment of the essential need for guidelines when working with green building materials. Scott Earnest (2021) emphasizes the significance of giving top priority to safety and well-being in industrial practices.

iv. Worker Feedback: The mean score of 4.19 indicates that contractors actively seek feedback from workers for health concerns related to materials, showing a commitment to addressing and improving health factors. This is in line with the viewpoint of Scott Earnest (2021), who emphasizes the importance of worker involvement in improving safety protocols.

v. Effective Communication: The mean score of 4.25 emphasizes the important role of effective communication among project stakeholders regarding health considerations, reflecting a shared understanding of its importance. The findings of Ahsen (2023) emphasize the significance of communication in facilitating sustainable decision-making for a more conducive work environment.

vi. Prioritization of Material Selection: The industry's strong emphasis on material selection, as indicated by the high mean score of 4.12, highlights its commitment to choosing materials that have demonstrated health advantages in green building projects. This is in accordance with the findings of a study conducted by Irina, Rahmalan, Krishna, and Wahid in 2013, which highlights the need of making informed choices about materials in order to promote sustainable construction.

vii. Health Assessments: The mean score of 4.25 suggests a consensus on the need for regular health assessments of construction workers on projects using green materials, reflecting an active approach to

worker well-being. This is consistent with Scott Earnest's (2021) focus on prioritizing the well-being and safety of employees.

viii. Protective Equipment Investment: Contractors, with a mean score of 4.24, recognize the importance of investing in protective equipment and tools designed for safe use with green materials, prioritizing the health and safety of construction workers. This is consistent with the suggestions of Scott Earnest (2021) regarding the implementation of suitable protective measures to ensure the safety of workers.

ix. Industry Promotion of Best Practices: The high mean score of 4.15 indicates a collective commitment to industry associations promoting best practices for health-conscious construction with green materials, emphasizing a shared responsibility for fostering a healthier work environment. This is consistent with the emphasis of (Marwa M. Gomaa Mayhoub *et al*., 2019) on ensuring quality control and ventilation in order to maintain a healthy indoor environment.

5. Conclusion

As a conclusion from this study, the following suggestions are outlined:

i. It is possible for regulatory bodies and organisations under the administrative government to collaborate with research institutions by providing financial assistance, providing support for programmes, and allocating resources for in-depth study on environmentally friendly construction materials.

ii. Various Associations and Organisations Serving the Industry. Research initiatives may be pioneered by groups representing the construction industry. These associations may do so by pooling resources, providing financial support for studies, and fostering collaboration between industry players, universities, and research institutions.

iii. The academic and research institutes that are universities. When it comes to the health impacts of different building materials, these groups are tasked with doing extensive and comprehensive research on the subject. Through the application of this information, legislation may be influenced, industry practices can be explained, and the adoption of defined standards for the use of healthier building materials can bring about the desired results.

iv. Developers and Construction Workers. They provide data from the actual world by actively participating in research and sharing their experiences acquired via practical application. It is possible that innovative and environmentally responsible building designs might be produced by incorporating the findings of research into construction methods.

v. Advocates and Non-Governmental Organisations (NGOs) are two types of organisations. Campaigning for more financing for research and the use of construction practices that are more health aware are both key roles that these groups play. Acting as watchdogs, they advocate for legislative changes that give health in construction a higher priority and raise awareness about the importance of health in building. There is a possibility that advocacy campaigns will have an effect on public opinion, drive legislative reforms, and bring attention to the need of using environmentally friendly materials in construction.

vi. Academic institutions and private businesses forming partnerships. Academic rigour and real-world insights from industry are brought together via collaborations between academic institutions and industry entities, which in turn promotes research and development.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Lee Chui Wei, Seow Ta Wee;* ***data collection:*** *Lee Chui Wei;* ***analysis and interpretation of results****: Lee Chui Wei;* ***draft manuscript preparation:*** *Lee Chui Wei, Seow Ta Wee, Norliana Sarpin, Haryati Shafii. All authors reviewed the results and approved the final version of the manuscript.*

Appendix A: Survey Form to Collecting Data

Figure 1 (a) (b) (c): Example of low-emitting flooring: Vinyl flooring, Sisal Carpet and Nylon Carpet

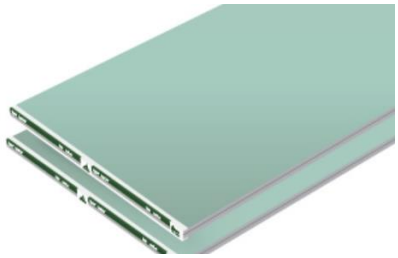

Figure 2: Moisture-resistant gypsum board

Figure 3 (a) (b) (c): Formaldehyde-free insulation: Cellulose insulation, cotton insulation and wool insulation

Figure 4 (a) (b): Design of green roof and soft partition boards

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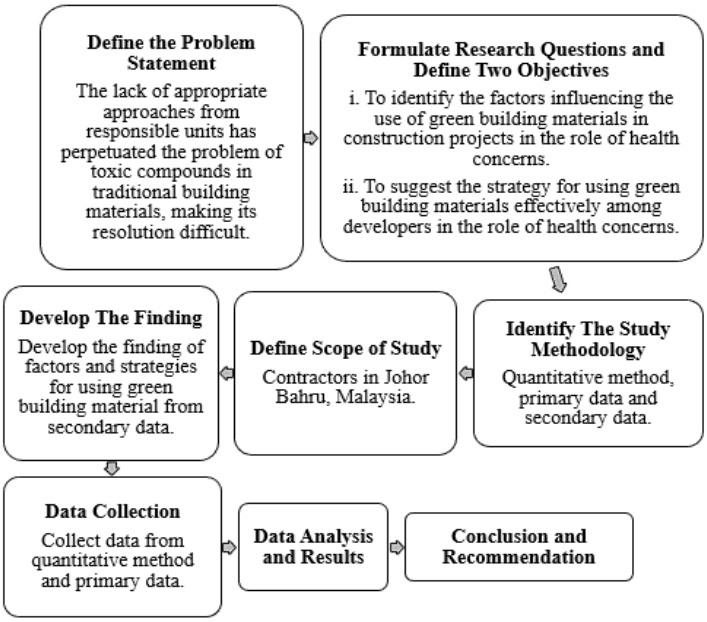

Figure 5: This study's methodology process

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size. *S* is sample size.

Source: Krejcie & Morgan, 1970

Figure 6: Krejcie and Morgan table

Table 1 (a) (b) (c) (d): Hypothesis of factors and strategies

Hypothesis of factors and Strategies

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Factors	Between Groups	1.938	4	.484	1.664	.162
	Within Groups	37.860	130	.291		
	Total	39.797	134			
Strategies	Between Groups	1.787	4	.447	1.533	.196
	Within Groups	37.894	130	.291		
	Total	39.681	134			

ANOVA Analysis for Age in Factors and Strategies

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Factors	Between Groups	6.373	3	2.124	8.326	<.001
	Within Groups	33.424	131	.255		
	Total	39.797	134			
Strategies	Between Groups	6.353	3	2.118	8.323	<.001
	Within Groups	33.328	131	.254		
	Total	39.681	134			

ANOVA Analysis for Race in Factors and Strategies

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Factors	Between Groups	.279	4	.070	.230	.921
	Within Groups	39.518	130	.304		
	Total	39.797	134			
Strategies	Between Groups	.517	4	.129	.429	.787
	Within Groups	39.164	130	.301		
	Total	39.681	134			

ANOVA Analysis for Level of Education in Factors and Strategies

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Factors	Between Groups	3.716	3	1.239	4.497	.005
	Within Groups	36.081	131	.275		
	Total	39.797	134			
Strategies	Between Groups	4.428	3	1.476	5.485	.001
	Within Groups	35.253	131	.269		
	Total	39.681	134			

ANOVA Analysis for Experience in Factors and Strategies

Table 2 (a) (b): The Factors Influencing the Use of Green Building Materials in Construction Projects in the Terms of Health Concerns

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Statistics						
		The use of green building materials can significantly reduce health risks for construction workers.	Green building materials contribute to better indoor air quality, which is essential for occupant health.	Construction projects that prioritize green materials tend to have fewer health-related incidents.	The potential health benefits of green building materials are well-understood by construction professionals.	Proper ventilation and air quality control are essential when working with green building materials.
N	Valid	135	135	135	135	135
	Missing	0	0	0	0	0
Mean		4.10	4.21	4.16	4.25	4.27
Median		4.00	4.00	4.00	4.00	4.00
Mode		4	4	4	5	5
Std. Deviation		.813	.754	.790	.789	.814
Variance		.661	.569	.625	.623	.663
Sum		554	568	561	574	577

		Workers' safety and health should be a primary consideration when selecting construction materials.	Training programs on the safe handling of green building materials are essential for construction teams.	Awareness of health risks associated with traditional construction materials influences the adoption of green materials.	Regulatory agencies should provide guidelines for the safe use of green building materials.	The construction industry should prioritize research on the health impacts of different building materials.
N	Valid	135	135	135	135	135
	Missing	0	0	0	0	0
Mean		4.25	4.24	4.11	4.33	4.16
Median		4.00	4.00	4.00	5.00	4.00
Mode		5	5	4	5	4
Std. Deviation		.740	.758	.740	.792	.755
Variance		.548	.574	.547	.627	.570
Sum		574	573	555	585	562

Table 3 (a) (b): The strategy for using green building materials effectively among contractors in the terms of health concerns

Statistics						
		Contractors should provide comprehensive training on the health benefits of using green building materials.	Collaboration between contractors, suppliers, and health experts can enhance the safe use of green materials.	Government incentives should specifically target projects that prioritize health-conscious green materials.	The development of safety protocols and guidelines for working with green building materials is essential.	Contractors should actively seek feedback from workers regarding health concerns related to materials.
N	Valid	135	135	135	135	135
	Missing	0	0	0	0	0
Mean		4.08	4.20	4.34	4.26	4.19
Median		4.00	4.00	4.00	4.00	4.00
Mode		5	4	5	5	5
Std. Deviation		.829	.700	.735	.722	.806
Variance		.687	.490	.540	.522	.649
Sum		551	567	586	575	566

		Effective communication among project stakeholders regarding health considerations is crucial.	Green building material selection should prioritize materials with proven health benefits.	Regular health assessments of construction workers should be conducted on projects using green materials.	Contractors should invest in protective equipment and tools designed for safe use with green materials.	Industry associations should promote best practices for health-conscious construction with green materials.
N	Valid	135	135	135	135	135
	Missing	0	0	0	0	0
Mean		4.25	4.12	4.25	4.24	4.15
Median		4.00	4.00	4.00	4.00	4.00
Mode		5	4	5	5	5
Std. Deviation		.770	.773	.760	.857	.815
Variance		.593	.598	.578	.734	.664
Sum		574	556	574	572	560

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