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Intergrate Upcycling Paddy Waste as Alternative Building Material for Sustainable Community Based Architecture

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Abstract

The construction industry consumes a significant amount of resources and generates waste, which contributes to environmental degradation. As a result, there is a growing demand for sustainable practises in the construction industry, such as the use of eco-friendly, affordable, and readily available alternative building materials. Upcycling paddy waste as an alternative building material is a promising solution that can significantly reduce paddy waste while also promoting sustainable practises. Paddy waste can be converted into a variety of alternative building materials such as rice straw- husk cement composite. A literature review was carried out using various databases to identify the benefits of paddy waste. The analysis shows that these materials have a number of benefits, including affordability, lower production cost, long lasting building material and environmental friendliness. Using such approaches can also improve community-based architecture and the standard of living for people living in Sekinchan. For instance, using paddy waste in construction can help preserve traditional building methods and cultural legacy, which is crucial in rural communities. Using this technique can also boost the local economy, provide doors for local employment, and encourage self-sufficiency. Therefore, the integration of upcycling paddy waste as an alternative building material for sustainable community-based architecture presents a promising solution for promoting eco-friendly practices in the construction industry.

Keywords: Paddy Waste, Rice Husk, Concrete, Construction

Introduction

Rapid urbanization has led to an increase in construction activities, which has resulted in the depletion of natural resources and a surge in waste generation. In this context, sustainable

and green architecture has become a need to reduce the ecological footprint of the built environment.

Rice being one of the staple crops of the world, and paddy waste such as rice husks and rice straw are generated in large quantities as by-products of rice production and there is any biomass that is still present in the field after the harvest period. Regardless of this fact, there are many environmental concerns related to the rice production system across the globe. One of the worries is the emissions of lethal greenhouse gases because of the different steps and procedures concerned with rice production and their contribution towards global warming. Integrate upcycling paddy waste as an alternative building material is a potential solution to this problem. The use of these agricultural waste products as a building material could not only reduce waste but also provide low-cost, eco-friendly building materials for sustainable architecture.

To show that paddy waste can be used as an alternative sustainable building material. Rice straw-husk cement composite is a promising sustainable building material due to its eco-friendly and cost-effective features. This composite material consists of rice straw and husk fibers, which are agricultural waste products, mixed with cement and water to form blocks or panels. The addition of rice straw and husk fibers to cement not only reduces the cost of construction but also reduces the amount of cement required, thereby reducing carbon emissions.

In addition, the use of agricultural waste as a building material reduces the amount of waste that would otherwise be burned, leading to air pollution and greenhouse gas emissions. A study investigated the mechanical properties of rice straw-husk cement composite and found that it exhibited good mechanical strength, thermal insulation, and acoustic insulation properties (Siddique et al., 2018). This indicates that rice straw-husk cement composite has the potential to be used in a wide range of building applications, including walls, roofs, and flooring.

Integrating paddy waste into sustainable architecture has several advantages, including reducing the environmental impact of construction activities and providing low-cost building materials for sustainable communities. It also helps to create a circular economy by converting waste into a resource, which could lead to the development of a sustainable supply chain for building materials. Furthermore, the use of upcycling paddy waste as an alternative building material can help to reduce the carbon footprint of construction, as it requires less energy to produce compared to traditional building materials.

In conclusion, there is a need for further research and development to explore the full potential of paddy waste as a building material and to address any potential challenges associated with its use. Nonetheless, the potential benefits of using paddy waste in sustainable architecture make it a promising alternative for the future.

Open burning of agricultural waste such as paddy waste has significant environmental drawbacks. Open burning of rice straw resulted in high emissions of particulate matter, carbon monoxide, and volatile organic compounds, which can cause respiratory problems and other health issues (Chen et al., 2019). Furthermore, the study found that open burning of rice straw also released large amounts of greenhouse gases such as carbon dioxide, methane, and nitrous oxide, contributing to climate change. In addition, the study found that open burning of agricultural waste also contributed to air and water pollution, leading to negative impacts on human and environmental health. Overall, open burning of agricultural waste such as paddy waste poses significant risks to both human health and the environment, making it an unsustainable and harmful practice. However, in order to mitigate the problems associated

with the deposition of open burning waste, it is crucial to have effective policies, strategies, and guidelines for paddy waste management. However, Malaysia currently lacks comprehensive policies and guidelines for paddy waste management, which has led to ineffective waste management practices, including open burning. The study found that the lack of proper waste management policies and strategies had led to the accumulation of paddy waste, which is often disposed of through open burning. This has resulted in significant environmental and health hazards, including air pollution, soil degradation, and loss of biodiversity. Therefore, there is an urgent need for Malaysia to develop and implement effective policies and guidelines for paddy waste management to address the challenges associated with open burning and promote sustainable waste management practices.

Moreover, the negative environmental impacts of building materials have raised global concerns about the availability of information on hazardous and toxic contents. Material usage is unavoidable in the building construction industry. To build and construct buildings, mega structures, and other structures, cement, bricks, timber, newer innovative composites, green accredited, and other acclaimed materials are used (Zarina et al., 2012)

The use of paddy waste as a construction material can indeed influence detrimental effects on sustainability. Paddy waste materials may have lower embodied energy and carbon footprint compared to traditional construction materials. However, there is a lack of methods for disposing of the paddy waste remaining in the fields after harvest in Malaysia. There is a problem with disposing of paddy waste, which is the leftover plant material after the rice crop has been harvested. Besides, there is also lack of considers of the composition of rice straw and husks, there is a lack of awareness or attention given to the potential uses of rice straw and husks, which are two components of paddy waste. These materials can be used to produce rice straw-husk cement composite (RS-HCC), which is a sustainable building material. However, the potential of these materials is not being fully realized due to a lack of understanding of their properties and potential uses.

Overall, this statement highlights the challenges associated with paddy waste disposal in Malaysia, as well as the potential of rice straw and husks to be used as a sustainable building material. To fully realize the potential of these materials, there is a need for increased awareness and investment in technology and infrastructure for paddy waste processing.

Methodology

The study employed a thorough literature review using several databases such as Scopus, Google Scholar, and Elsevier. Keywords used for the search included paddy waste, rice husk, concrete, and construction. Exploring on these keywords, the databases enlisted above was implemented to identify related literature pertaining to the study.

Results and Discussion

In line with the objectives of the study, literature reviews have been done following the sub themes that have been added to the research question construct. Deductive codes that lead to the two sub-topics identified are the challenges of upcycling paddy waste and paddy waste as alternative building materials. The literature review for each deductive is as follows:

Challenges of Upcycling Paddy Waste

Upcycling paddy waste presents several challenges that need to be addressed to make this process economically and environmentally viable. One of the primary challenges is the high silica content in rice husks, which makes it difficult to achieve a consistent mix with other

materials such as cement (Anwar et al., 2019). Additionally, the lack of standardized methods for processing paddy waste can make it difficult to produce high-quality products consistently. Another challenge is the transportation and storage of paddy waste, which can be costly and require specialized equipment. Besides, the lack of awareness and incentives for using upcycled paddy waste products in construction can limit the demand for these materials (Nguyen et al., 2021). Addressing these challenges will require collaboration between researchers, industry stakeholders, and policymakers to develop standardized methods for processing paddy waste and creating markets for upcycled products.

One of the challenges is related to the high silica content in rice husks, which makes it difficult to achieve a consistent mix with other materials such as cement. (Anwar et al., 2019). To address this challenge, researchers have been exploring ways to pretreat rice husks to remove the silica and improve the quality of the resulting composite materials.

Another challenge is the lack of standardized methods for processing paddy waste. Paddy waste can vary in its composition and properties depending on factors such as the rice variety, harvesting method, and weather conditions (Nguyen et al., 2021). This can make it difficult to produce high-quality products consistently. To address this challenge, researchers have been developing standardized methods for processing paddy waste, such as pretreatment techniques and composite fabrication methods.

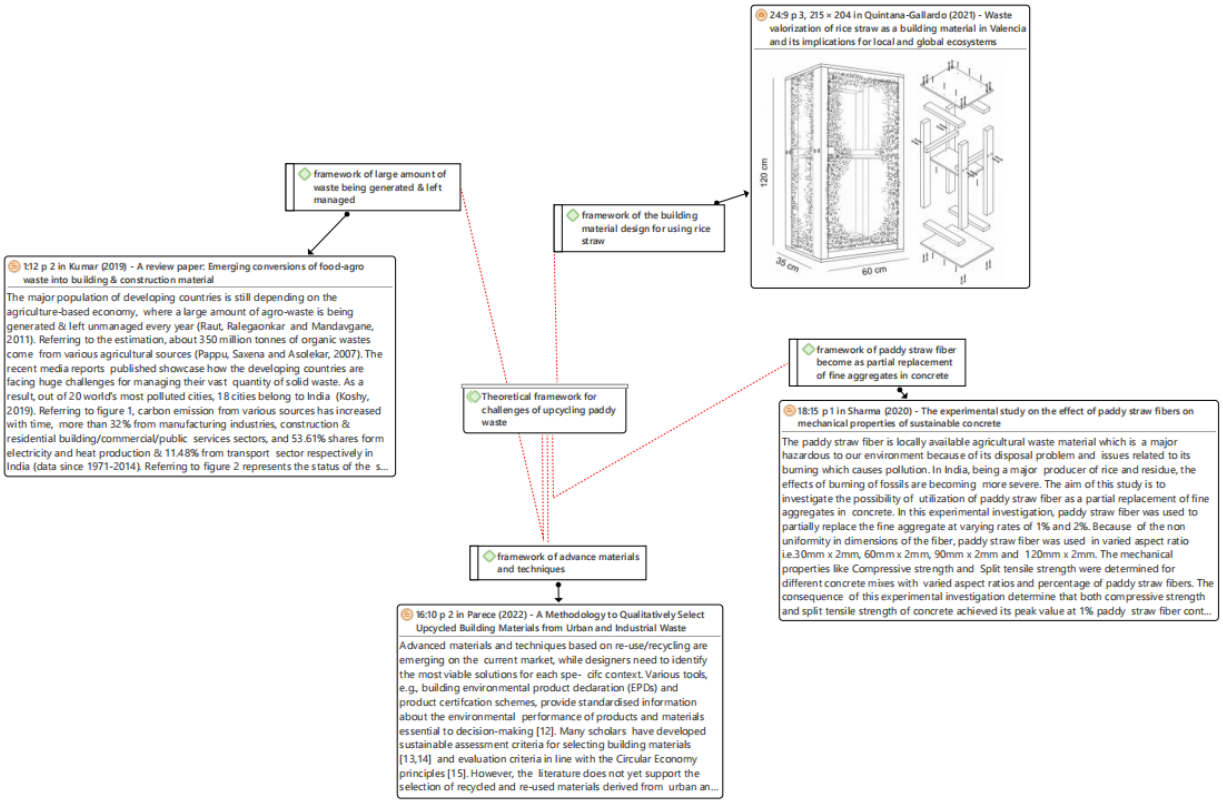
For transportation and storage of paddy waste can also be challenging. Paddy waste is bulky and lightweight, which can make it difficult and costly to transport over long distances. Storage of paddy waste can also be problematic, as it can be susceptible to moisture and microbial degradation (Nguyen et al., 2021). To address this challenge, researchers have been exploring ways to densify paddy waste and reduce its moisture content for easier transportation and storage.

Finally, the lack of awareness and incentives for using upcycled paddy waste products in construction can limit the demand for these materials (Nguyen et al., 2021). To address this challenge, there is a need for increased awareness and education about the benefits of using upcycled paddy waste products in construction, as well as incentives such as tax breaks or government subsidies to encourage their use.

Overall, these challenges highlight the need for continued research and development to address technical, economic, and social barriers to upcycling paddy waste into high-value products. Collaboration between researchers, industry stakeholders, and policymakers will be critical to creating a sustainable and viable paddy waste upcycling industry.

It is important to understand the properties and characteristics of the paddy waste biomass, including rice straw and rice husk, to develop effective methods for upcycling this waste material into useful products. Rice straw and rice husk both have high cellulose and lignin content, which makes them suitable for use as building materials. However, rice husk also contains high amounts of silica, which can make it challenging to achieve consistent mixing with other materials like cement. One approach to overcoming this challenge is to pretreat the rice husk to remove the silica before mixing it with other materials. In addition to considering the properties of the paddy waste biomass, material engineers must also address issues related to transportation, storage, and durability of upcycled products. This includes developing methods for densifying and reducing moisture content of paddy waste biomass to facilitate transportation and storage and using protective coatings or treatments to enhance the durability and resistance to environmental factors like moisture and heat. Through

research and development, material engineers can help to create a sustainable and economically viable upcycling industry for paddy waste biomass.



Paddy waste as alternative building materials

Paddy waste biomass has been increasingly recognized as a promising alternative building material due to its various advantages over traditional building materials. As a byproduct of rice production, paddy waste biomass is abundant, locally-sourced, and renewable. This means that it has a low environmental impact and contributes to sustainable development.

In addition, using paddy waste biomass as a building material can reduce the amount of agricultural waste burned in the field, which is a major source of air pollution and greenhouse gas emissions. This can help to improve air quality and reduce the negative impacts of climate change. Furthermore, paddy waste biomass products have good thermal insulation properties, which can help to reduce energy consumption in buildings, especially in regions with extreme temperatures. This makes them a viable option for energy-efficient construction.

Additionally, the use of paddy waste biomass as a building material can provide economic benefits to farmers and communities by creating a local supply chain for processing and manufacturing. However, there are still several challenges that need to be addressed to promote the widespread use of paddy waste biomass as a building material. These include processing techniques, durability, market acceptance, and building codes and standards.

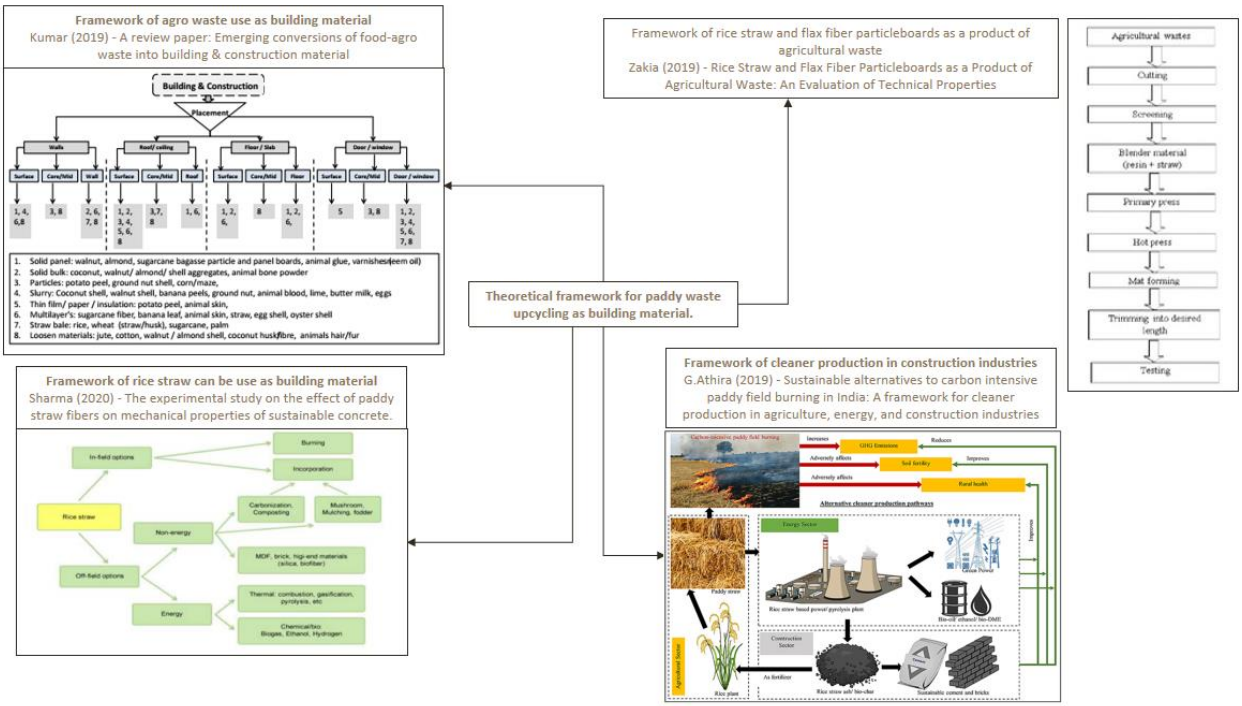
In addition to the benefits mentioned above, paddy waste biomass also has potential health benefits. A study found that the use of rice straw panels as wall insulation material in buildings can improve indoor air quality by reducing the levels of airborne particulate matter and volatile organic compounds. These compounds are known to have adverse health effects, including respiratory problems, allergies, and cancer. By using paddy waste biomass as a

building material, indoor air quality can be improved, thereby promoting a healthy living environment. (Bhatia et al. 2017)

Moreover, the use of paddy waste biomass as a building material can also create job opportunities and boost local economies. The utilization of rice straw in building construction in Egypt can generate income for rural communities, as it creates a demand for labor in the collection, transportation, and processing of the material (Amin and Salem, 2020). This can help to improve the livelihoods of farmers and reduce rural poverty.

However, the use of paddy waste biomass as a building material also has some challenges, particularly in terms of durability and resistance to moisture and pests. Rice straw panels have good thermal insulation properties but are susceptible to moisture and fungal decay, which can affect their durability (Dissanayake et al., 2019) To address these challenges, additional treatment and coating methods may be required.

In conclusion, paddy waste biomass is a promising alternative building material that offers various environmental, social, and economic benefits. However, there are still several challenges that need to be addressed to promote its widespread use in construction. Further research and development are needed to improve its durability, resistance to moisture and pests, and market acceptance.



Conceptual Framework

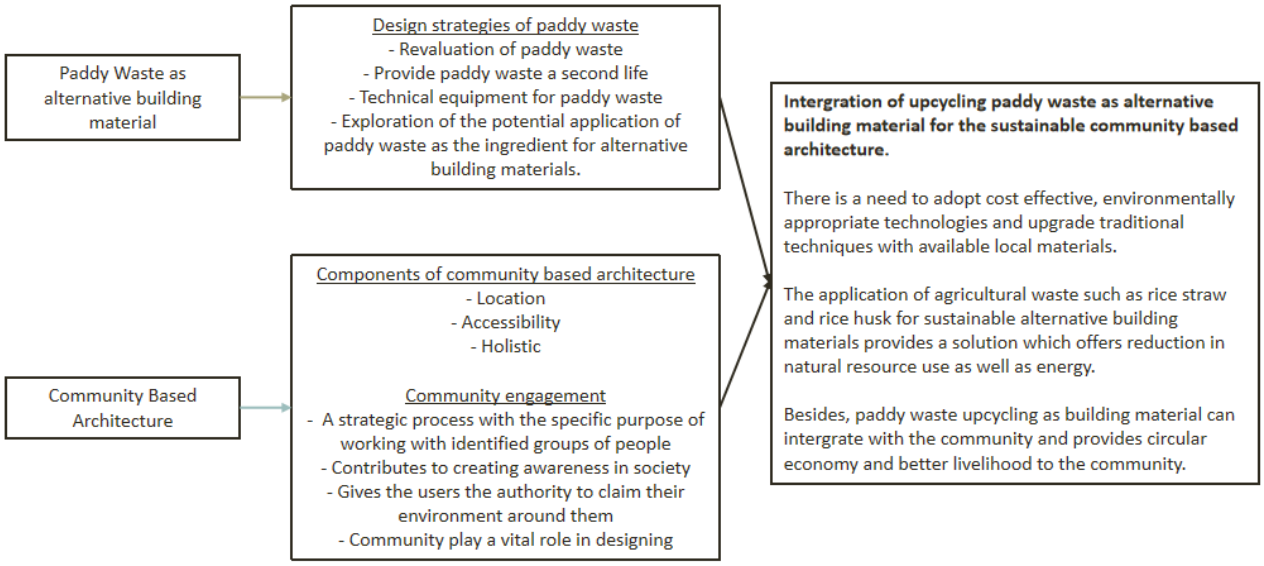
The conceptual framework aims to address the need for cost-effective and environmentally appropriate technologies, while also upgrading traditional techniques with available local materials. The framework highlights the application of agricultural waste such as rice straw and rice husk for sustainable alternative building materials as a solution that offers reduction in natural resource use as well as energy.

The process involves working with identified groups of people in the community to create awareness and provide training on the benefits of using paddy waste as a building material. This approach not only provides valuable input in the design and production process but also

contributes to creating awareness in society and gives the users the authority to claim their environment around them.
The use of paddy waste as a building material can contribute to sustainable development by addressing various environmental and social issues. It is cost-effective, environmentally friendly, and reduces the need for natural resources such as wood and concrete. Additionally, it contributes to the circular economy, which promotes the reuse of materials and reduces waste.

The involvement of the community in the production process can provide new economic opportunities and better livelihoods for local communities. This approach also enhances the effectiveness of the technology and results in materials that meet the needs and preferences of the local population.

Overall, the conceptual framework advocates for the adoption of cost-effective and environmentally appropriate technologies, such as paddy waste upcycling, to contribute to sustainable development and enhance the livelihoods of local communities.



Limitation

There still exists limitation of studies on integrating upcycling paddy waste as an alternative building material for sustainable community-based architecture due to limited awareness as it is still a relatively new and emerging concept, technical challenges such as developing appropriate processing techniques, ensuring the durability ad structural integrity of the material, and meeting building code and safety standards, cost and economic viability, and regulatory and policy framework.

Conclusion and Future Directions

In conclusion, this concept paper suggests that paddy waste can be a viable alternative building material for community-based architecture. This is because paddy waste, which is usually burned or discarded, has the potential to be used as a sustainable and eco-friendly building material. By utilizing paddy waste as a building material, we can reduce waste and minimize environmental damage.

The concept paper also indicates that the process parameters and knowledge of paddy waste were optimized, which means that the researchers have found the best way to process paddy waste to make it usable as a building material. This optimization process may have involved experimenting with different treatment methods such as drying, shredding, or compressing the waste material. By optimizing the process, the researchers have ensured that the paddy waste is durable, stable, and safe for use in construction.

Furthermore, the technological bundle is prepared for manufacturing on a large scale in industry. This suggests that the researchers have developed a practical method for producing paddy waste building materials on a large scale. The technological bundle may include information about the equipment needed to produce the material, the production process, quality control measures, and safety protocols.

Overall, this concept paper provides evidence that paddy waste can be a useful and sustainable building material for community-based architecture. By optimizing the process and developing a technological bundle for large-scale production, the researchers have made it easier for manufacturers to adopt this material and integrate it into their building projects. This could lead to a significant reduction in waste and a more sustainable approach to building construction.

Stakeholder and local city council (eg National Solid Waste Department Malaysia, Ministry of Environment, Ministry of Health, the various academic institutions and NGO's) In Malaysia, waste management and waste minimization are not the sole responsibility of Local Authorities but most government agencies like the Ministry of Well-being Housing and Local Government, National Solid Waste Department Malaysia, Ministry of Environment, Ministry of Health, the various academic institutions and NGO's should work together to achieve this.

Proper networking and linkages amongst these stakeholders will help in enhancing the potential for Agriculture Waste Management System in Malaysia.

Institutions need to outline the policies and strategies to improve the role of each stakeholder. There are also lack of policies, strategies and guidelines on Agriculture Waste Management System. In order to come up with an efficient and sustainable Agricultural Waste Management [AWM] in Malaysia, the following issues need to be addressed.

The potential of this finding of this research is the application of paddy waste as the ingredient for alternative building materials and paddy waste as alternative building can contribute to the community and provides circular economy and better livelihood to the community.

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