Achieving Environmental Sustainability through the Production of Safety Glass Boxes from Plastic Waste – A Conceptual Approach

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ABSTRACT

This research addresses the need for modern technology in construction by proposing a new method for transporting and storing glass blocks. Glass blocks are widely used in architectural and design applications due to their unique blend of transparency, durability, and insulation properties. However, due to the fragile nature of glass being prone to breaking, brittleness, and surface etching, manufacturers face challenges in transporting glass blocks from the factory to construction sites. This study aims to propose a conceptual for a new innovative approach to enhance the transportation and storage of glass blocks in construction site. This study utilized a simulation technique to visualize the proposed safety box of glass blocks. The study identifies current challenges and introduces a safety inventory box made from recycled plastic, equipped with a QR code for improved inventory management. This innovation not only enhances the durability and safety of glass block storage but also aligns with global sustainability trends and SDG12 which minimizing waste through prevention, reduction, recycling, and reuse. The use of recycled materials and smart technology streamlines the process, reducing errors and supporting environmental goals in construction projects.

Keywords: Glass blocks, QR Code, Safety, Storage

INTRODUCTION

Glass is a popular material that breaks easily and is prone to damage because of its aesthetic appeal. This difficulty is further compounded by modern architectural design trends that emphasise bigger glass blocks, which affect labour costs, project timeframes, and installation periods. Glass blocks' slick surface produces risks that might result in mishaps and injuries. The purpose of this research is to investigate creative ways to increase productivity and safety when transporting and storing glass blocks. By solving the issues of glass block transportation and storage, it advances methods and approaches within the industry, guaranteeing the reduction of any hazards related to glass block operations.

The Industrialized Building System (IBS) revolutionizes construction by utilizing prefabricated and standardized components to significantly lower costs, reduce environmental impact, and enhance efficiency, quality, and speed. By addressing the limitations of traditional on-site construction, IBS ensures greater precision, faster project completion, and superior quality control (Mohamad et al., 2011). Since IBS components are produced in controlled environments, they minimize defects and common construction issues. While the initial investment in IBS may be higher, the long-term benefits—such as substantial cost savings, reduced waste, lower energy consumption, and minimized environmental impact—make it a highly sustainable and efficient approach (Azree et al., 2014). With its various systems, including penalized, volumetric, and hybrid models, IBS represents a transformative shift in the construction industry, promising to redefine future building practices.

Moreover, the Industrialized Building System (IBS) is a construction approach that utilizes pre-manufactured components to assemble buildings (refer to Table 1). These components are produced systematically using machines, moulds, and other mechanical tools. Some elements are fabricated off-site and later finalized (Azree

et al., 2014). Once completed, these parts are transported to construction sites for assembly and installation.

Table 1: Types of IBS

No	Types of IBS
1	Precast Concrete framing, panel and box
2	Formwork system
3	Prefabricated framing timber
4	Blockwork system
5	Metal framing system
6	Hybrid Innovative

As part of this innovative concept, the glass block system has been integrated as an IBS feature. In the construction industry, glass blocks can serve as a component for wall systems. These glass blocks are manufactured in a controlled facility and are equipped with protective features to prevent breakage, along with a QR code for easy information access. This technology simplifies tracking and retrieving data related to the glass blocks. Additionally, it reduces manufacturing costs and labour requirements. Incorporating recycled plastic in the process supports Sustainable Development Goal (SDG) 12, which promotes responsible production and consumption.

Problem Statement

Glass blocks, known for their strength, aesthetic appeal, and transparency, are increasingly used in construction projects despite their susceptibility to damage and fragility. However, poor handling and management can lead to breakage, project delays, additional costs, and potential safety hazards. The transportation of glass blocks over long distances further increases the risk of damage due to road vibrations, sudden impacts, and environmental factors (Kumar & Sharma, 2023; Mahmutluoglu & Bagriacik, 2021). These challenges negatively impact the efficiency and cost-effectiveness of construction projects, raising concerns about environmental impact and sustainability. Addressing this issue requires a comprehensive approach, including durable packaging designs, strict handling protocols, and optimized logistical strategies (Cohen, 2018). Glass manufacturers, transportation companies, and construction firms need to collaborate in developing technological solutions, standardized procedures, and training programs to enhance the safety and efficiency of glass block transportation. In conclusion, the transport of glass blocks presents a major challenge in the construction industry, necessitating joint efforts to minimize breakage, ensure project continuity, and promote sustainable practices. Therefore, this research aims to propose an innovative idea for improving the transportation and storage of glass blocks at construction sites.

METHODOLOGY

This research adopts a conceptual approach in which the innovative idea is simulated and visualized using SketchUp software.

DISCUSSION

In today's innovation-driven market, leaders must understand how to generate outstanding ideas. To foster creative insights and encourage collaborative creativity with emerging technologies, leaders must champion and support ideas while helping their organizations embrace diverse perspectives. Both actions are vital. Innovation can be described as the development of new products, processes, or services that are original, relevant, and valuable, achieved through the embodiment, integration, and/or synthesis of knowledge (Super User, 2020).

The concept for this innovation begins with the selection of the IBS component, which in this case is the glass block. To ensure the protection of the glass block during transportation and storage, advanced technology is required.

This innovation also incorporates elements of smart building and aligns with the Sustainable Development Goals (SDGs). The smart technology aspect involves generating a QR code for tracking and accessing information, contributing to the goal of Sustainable Cities and Communities as outlined in the SDGs.

By integrating smart technology with the SDGs, the innovation leads to the development of green technology. This involves using recycled plastic waste to create protective boxes for the glass blocks. This recycling process helps reduce the carbon footprint and is more environmentally friendly.

The proposed material for glass block storage is derived from waste plastic materials. Akhtar (2023) discussed that the issue of plastic waste pollution is escalating worldwide at an alarming rate, with a significant portion of plastic waste never being recycled. According to the United Nations Environment Programme, disposable plastics such as supermarket bags, cartons, and containers constitute most of the plastic packaging. These materials, designed for single use, are often discarded after just one cycle of production. Their growing prevalence has played a major role in the surge of plastic waste. According to a 2019 study by the Worldwide Fund for Nature (WWF), Malaysia ranks second in Asia for annual per capita plastic consumption. In terms of total waste generated, Malaysia surpasses much larger nations like China, Indonesia, the Philippines, Thailand, and Vietnam, with each person producing 16.78 kg of plastic waste. Malaysia's plastic production industry is one of the largest globally, with over 1,300 manufacturers. In 2016, the country sold resins valued at RM30 billion to plastic producers worldwide (Kaur, 2021).

According to Awoyera and Adesina (2020), plastic waste has several distinct characteristics that influence its environmental impact and treatment solutions. One notable feature is its durability; plastics are engineered to withstand a variety of climatic conditions, enabling them to persist in natural environments for decades or even centuries. While this durability enhances product longevity, it significantly contributes to pollution when plastic waste is improperly discarded. Additionally, recyclable plastics come in many forms, including polyethene (PE), polypropylene (PP), and polyethene terephthalate (PET), each with unique properties and recycling requirements Another advantage of plastic is its lightweight nature, which makes it easy to transport, but also allows it to be carried by wind and water, spreading pollution over vast distances. Lastly, plastic waste often contains compounds such as plasticizers and flame retardants, which can leach into the environment, posing significant health risks to wildlife and humans. These characteristics underscore the urgent need for comprehensive waste management strategies to effectively mitigate the environmental impact of plastic waste. Addressing this issue requires not only improving recycling processes but also reducing plastic use, promoting biodegradable alternatives, and implementing stricter regulations to manage plastic waste disposal and its harmful by products.

RESULT

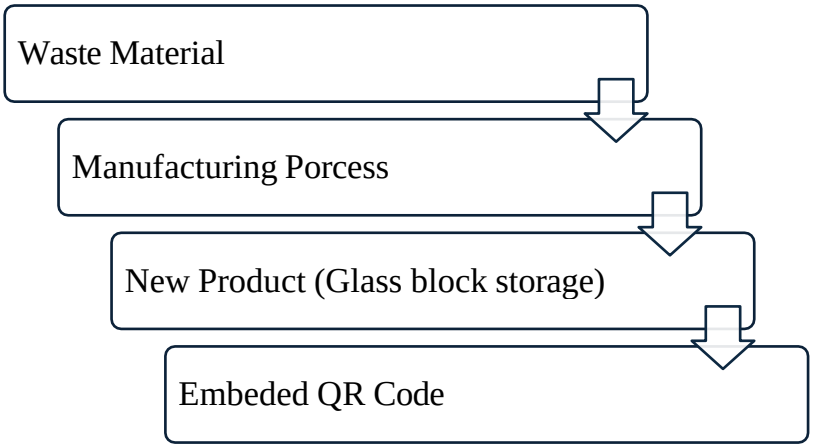

Figure 1: Simulation step for Glass Block Storage

As shown in Figure 1, the production of glass block storage begins with waste material. The waste material used for this innovative product is plastic. Once the plastic waste is sorted and cleaned, it is shredded into small flakes, increasing its surface area for easier melting and processing. These shredded plastics are then melted down and moulded into larger pieces or pellets, ready to be transformed into new, innovative products. Finally, a custom QR code is generated based on the client's request, allowing for seamless tracking and access to important product information. This efficient recycling process not only reduces plastic waste but also opens the door to cutting-edge, sustainable solutions.

The proposed safety inventory box, made from recycled plastic waste, provides a durable and eco-friendly solution for storing glass blocks, addressing both safety and environmental concerns. This innovative initiative not only offers a secure method for storing glass blocks but also contributes to reducing plastic waste and environmental pollution. The primary function of the safety inventory box is to protect glass blocks from cracking during storage and transportation. Designed to withstand external forces and absorb shocks, this sturdy packaging ensures the glass blocks remain intact and damage-free. By creating a safe and cushioned environment, the box significantly minimizes the risk of breakage, preserving the integrity and quality of the glass products. Additionally, using this protective packaging reduces the likelihood of financial losses and operational disruptions caused by damaged items. As a result, the safety inventory box plays a vital role in enhancing both the reliability and efficiency of the glass product supply chain.

The QR code on the safety inventory box enables convenient access to information via smartphone. As a versatile platform for storing and retrieving various types of data, the QR code can integrate multiple elements. While designed specifically for glass blocks, it can serve a range of purposes, primarily in construction applications, such as wall partitions in homes. The core concept behind this innovation is a QR code that contains key details, including the floor plan, glass block code, quantity, colour, and supplier information. Figure 2 and Figure 3 illustrate this proposed innovation concept.

Figure 2: Proposed Innovation Idea

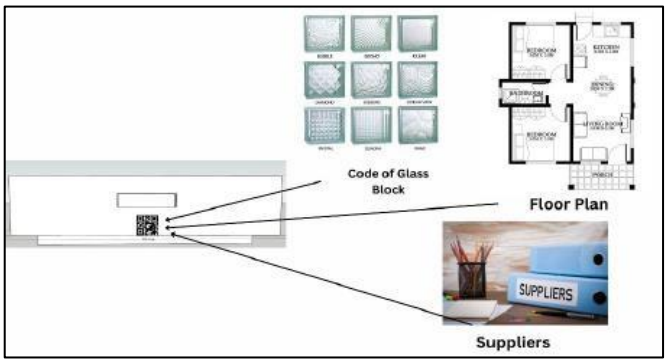

Figure 3: Proposed Innovation Idea

The proposed design for the glass block storage box was created using a software program called SketchUp. SketchUp is used to transform an innovative concept into a visual model that is easily understandable, rather than relying solely on imagination or basic sketches on paper as shown in Figure 4.

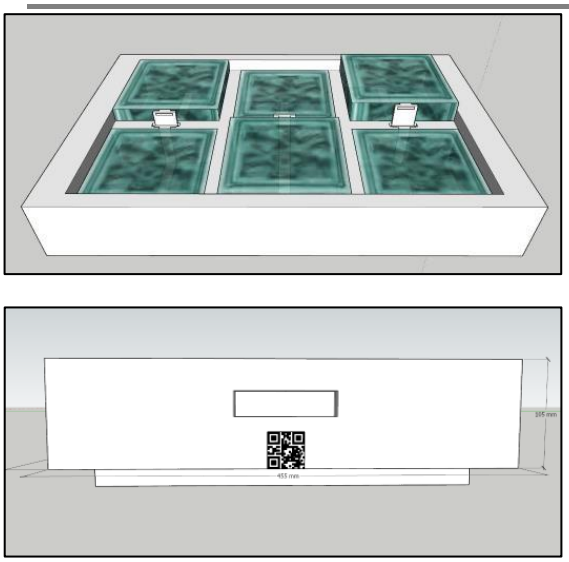

Figure 4: Visualization of Innovation Idea

Figure 5 illustrates the simulation of assembling the glass storage box made from recycled materials. The process starts with preparing the box to dimensions that match the size of the glass block. Following that, the glass holder is positioned to elevate the glass block.

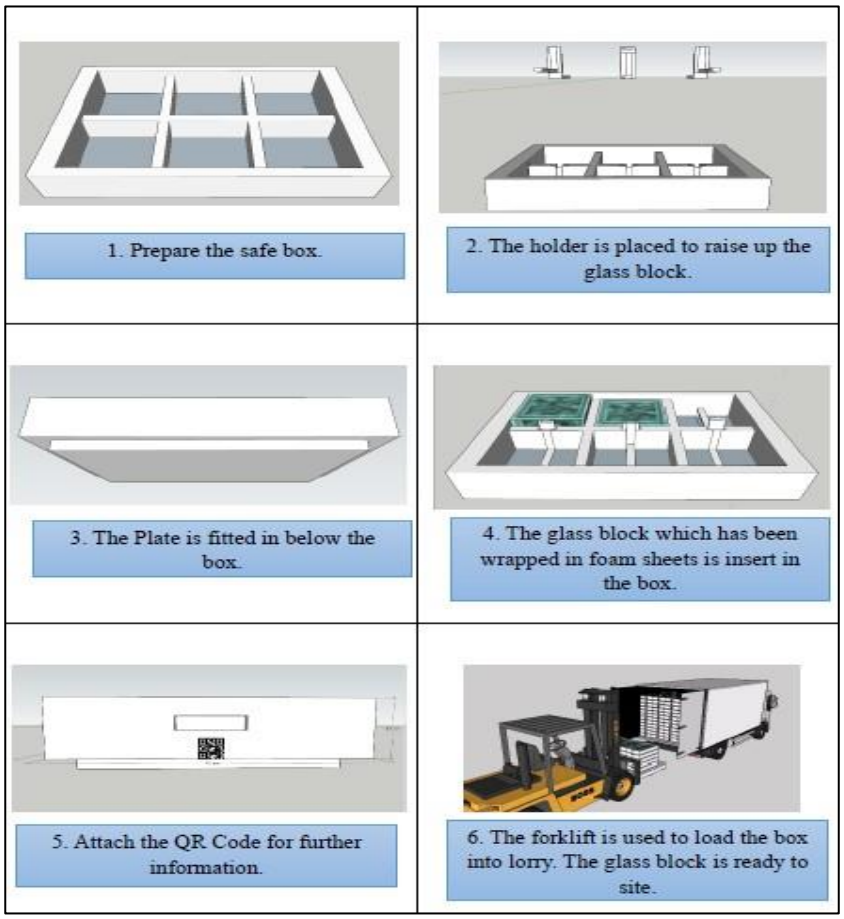

Figure 5: Simulation of glass block storage

After the holder is secured, a plate is placed beneath the box to stabilize the glass block. The final step before delivering the glass block to the construction site is attaching the QR code to the storage box.

CONCLUSION

The development of renewable waste materials for glass blocks represents a significant breakthrough,

particularly suited for integration into integrated building systems (IBS) and smart buildings. This innovation promotes the digitalization of construction processes, ultimately enhancing the efficiency of QR technology. However, several challenges must be addressed to ensure the effective management of transporting and storing glass blocks. These challenges include installation, the cost of producing the glass blocks, and transportation to the site. To successfully manufacture this type of innovation, several issues must be resolved.

The primary goal of this groundbreaking achievement is to create environmentally friendly technology that eliminates carbon dioxide emissions. This is achieved by utilizing waste materials, as billions of tonnes of plastic are discarded in landfills and oceans worldwide each year. The integration of QR technology in this innovation—specifically, a QR code applied to the packaging of glass blocks—aligns with the Sustainable Development Goals (SDGs). It particularly focuses on promoting sustainable cities and communities, as well as encouraging responsible consumption and production.

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