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Optimizing Green Supply Chains in the Production of Eco-Friendly Bricks

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***Abstract*-- This paper explores the potential of ecological bricks as a sustainable alternative to conventional clay and concrete bricks by addressing the environmental issues linked to traditional brick production, such as high embodied energy, carbon emissions, and resource depletion. Using a review-based approach, it synthesizes existing research on bricks developed from waste materials like construction debris, municipal waste, and industrial by-products, analysing various production techniques and their feasibility. The findings reveal that waste-derived bricks show strong promise in sustainability and waste recycling, though broader adoption requires improvements in technical performance, economic feasibility, policy support, and awareness. By consolidating current advancements, the study highlights ecological bricks as a viable solution for resource conservation, waste management, and carbon reduction, contributing valuable insights for future research and sustainable construction practices.**

I. INTRODUCTION

The construction industry is widely recognized as one of the primary drivers of urbanization and economic growth. It plays a vital role in creating infrastructure, housing, and facilities that directly contribute to societal development. However, this sector is also among the most resource-intensive and environmentally damaging industries. The extraction of raw materials, extensive energy consumption, generation of construction and demolition (C&D) waste, and the emission of greenhouse gases collectively result in a significant environmental footprint. As urbanization accelerates globally, the ecological implications of conventional construction practices are becoming increasingly concerning, demanding a paradigm shift towards more sustainable and responsible approaches.In recent decades, sustainability has become a central theme in construction research and practice. Governments, environmental organizations, and the building industry have developed policies and guidelines to reduce adverse environmental impacts and promote ethical practices. These initiatives emphasize waste minimization, recycling, and reclamation, especially from demolition activities that otherwise contribute to massive landfill volumes and ecosystem degradation.

The adoption of circular economy principles in the construction sector highlights the need to view waste not as a liability but as a valuable resource for new materials and innovative products.

II. REVIEW OF LITERATURE

Saran and Sandhwar (1990) have listed that most of the migrant labourers in the brick industry are treated as bonded labourers and they are neither allowed to communicate with their family members nor permitted to go back to their native places during mid-season. All sorts of inhuman measures like physical and mental torture, sexual abuse, and the kidnapping of kids, etc., are adopted by the employers. The maternity benefits are not paid, and no medical assistance is provided to them for common diseases. There is no compensation paid to the injured, deceased, or their dependents. The livingconditions of these women workers are extremely inhuman.

Lingam (1990) in his study has made an analysis of the structure of brick units in Thovalai Taluk in Kanyakumari District in Tamil Nadu, and carefully analysed the capital structure of the brick units. He has examined the cost structure, employment pattern, the components of working capital, wage structure, and methods of sales, strategy adopted by brick units in order to promote the sales volume and sales value of bricks in the study area.

Mathur (1990), in his article, stressed the need for manpower planning in the brick kiln industry because the industry has been facing a shortage of skilled labourers, such as molders and firemen. To cater to the needs of this industry and to increase productivity, it is necessary to make an assessment of the availability and the demand of manpower for operating this industry. Training is required for inculcating the requisite types of skills and to orient the skilled workers to newer skills.

N. David (1997) in his study focused on the marketing of bricks in Radhapuram taluk, the mode of sales, the promotional measures, and the relationship between selling price and various factors relatedto selling price.

Manoharam E (1998) in his study has studied the scale of technology and efficiency of brick industries in Tamil Nadu.

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He has chosen two districts for his research study, viz, Chengalpattu and Dharmapuri. The study revealed that there is a close relationship between the size of the unit and the technology adopted, and efficiency in terms of operation and economies of scale in production. This study has confirmed the fact that whenever the size of the unit is large, modern technology can be used, which in turn leads to an increase in production through improvement in efficiency. Further, the study has failed to discuss the environment and working conditions of labourers in general, and particularly the marketing problems faced by the brick industries.

III. Objectives Of The Study

- To analyze awareness about ecological bricks.
- To promote ecological bricks in civil construction.

IV. Research Methodology

Research methodology refers to the systematic framework of techniques and procedures adopted in a study to collect, assemble, and evaluate data to achieve the research objectives. In this study, the methodology has been designed to provide a comprehensive understanding of how awareness regarding ecological bricks can be effectively promoted among stakeholders in the construction sector.

V. Research Design

The study adopts a descriptive research design, as it seeks to examine the opinions, perceptions, and awareness levels of individuals concerning ecological bricks. The focus is on collecting both quantitative and qualitative data to evaluate current knowledge, attitudes, and the potential acceptance of eco-friendly construction materials.

VI. Sampling Technique And Sample Size

To ensure representativeness, the systematic random sampling technique was employed. This method allows for an unbiased selection of participants while maintaining adequate coverage of the target population. A total of 120 respondents were chosen for the study. These respondents were identified as relevant stakeholders, including construction professionals, academicians, policymakers, and general consumers with some level of exposure to construction activities.

VII. Data Sources

Two types of data sources were used in this research:

1. *Primary Data* – Primary information was collected directly from respondents through a structured questionnaire. The questionnaire was carefully designed to capture demographic details, awareness levels, perceptions, and willingness to adopt ecological bricks. Both closed-ended and open-ended questions were included to gather measurable insights and descriptive feedback.
2. *Secondary Data* – To supplement and validate the findings from primary data, secondary sources were consulted. These included official records, government websites, industry reports, research journals, conference proceedings, and published papers. Such sources provided context, supported the literature review, and helped in establishing the relevance of ecological bricks within sustainable construction practices.

VIII. Data Analysis Tools

The collected data were systematically organized and analyzed using statistical tools. Specifically:

- Percentage Analysis was used to interpret the distribution of responses and quantify levels of awareness, acceptance, and perception among respondents.
- Descriptive statistics were employed to summarize key trends.

IX. Scope And Relevance Of Methodology

This methodology is intended not only to measure the current awareness of ecological bricks but also to identify gaps in knowledge and opportunities for promoting their adoption. By combining primary insights with secondary evidence, the study ensures a balanced and credible understanding of the research problem. The systematic sampling approach, coupled with reliable tools of data analysis, enhances the validity of the findings and provides a strong basis for drawing meaningful conclusions.

X. Gent Waste Bricks

The Gent Waste Bricks represent an innovative step towards sustainable construction and circular design.

These bricks were specifically developed for the facade of the new Design Museum Gent extension in Ghent, Belgium, as part of a broader commitment to reducing the project's environmental footprint. Unlike conventional clay or concrete bricks, Gent Waste Bricks are lime-cured and produced entirely from recycled municipal waste, offering a low-carbon alternative to traditional building materials.

The production process replaces high-energy firing methods with lime curing, which requires significantly less energy and reduces greenhouse gas emissions compared to conventional kiln-fired bricks. Additionally, sourcing waste locally minimizes transportation-related emissions, aligning with circular economy principles. The bricks are engineered to meet structural and durability standards, ensuring they perform effectively as a facade material while carrying a unique identity tied to Ghent's local context.

Source: www.architectureanddesign.com.au

These bricks contain 63% waste and are cured rather than fired. The lime captures CO2 from the atmosphere during the curing, sequestering carbon over the life of the building. The brick also delivers the required strength and resilience to stand up to external conditions.

The manufacturing process and the use of locally sourced recycled materials produce a brick that contains a third of the embodied carbon of a clay brick over a 60-year lifecycle.

FLY ASH BRICKS

Source: www.architectureanddesign.com.au

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Fly ash bricks are an innovative and eco-friendly alternative to conventional clay bricks, manufactured primarily from fly ash, a fine industrial by-product generated in large quantities by thermal power plants. Traditionally regarded as waste, fly ash poses significant disposal challenges, often ending up in landfills or ash ponds, where it can create environmental hazards. By converting this by-product into a valuable construction material, fly ash bricks not only mitigate waste management issues but also contribute to reducing the ecological footprint of the building industry.

These bricks are produced using hydraulic compression machines, which compact a carefully proportioned mix of fly ash, sand, and other additives, followed by curing and drying. Unlike traditional clay bricks, which require energy-intensive kiln firing, fly ash bricks are manufactured through a process that avoids the burning of fossil fuels, thereby minimizing greenhouse gas emissions and significantly lowering their embodied carbon. This low-energy process makes them a highly sustainable alternative within modern construction practices.

K-BRIQ

Source: www.architectureanddesign.com.au

The K-BRIQ is one of the most groundbreaking innovations in sustainable building materials, developed to tackle both the environmental impact of construction waste and the growing demand for resource-efficient alternatives to traditional bricks. First test-launched in August 2019 after more than a decade of dedicated research at Heriot-Watt University in Scotland, the brick has since attracted global attention as a model of circular economy-driven innovation.

The product was commercialized by Kenoteq, a Scottish clean technology company focused on sustainable construction solutions. Its development aligns with European Union waste regulations, which mandate that 70% of construction and demolition (C&D) waste must be recycled rather than sent to landfill. This policy context, combined with the UK's increasing reliance on imported bricks to meet construction demand, created fertile ground for a solution like K-BRIQ that could close the loop on waste while reducing dependency on external suppliers.

XI. Analysis And Interpretation

Table 1.
Table showing the Age of the Respondents

S. No	Age	No. Of. Respondents	Percentage (%)
1	25 to 34 years	75	62.5
2	35 to 44 years	33	27.5
3	45 to 55 years	12	10
Total		120	100

Source: Primary Data

The above table shows that out of 120 respondents taken for the study, 62.5% of the respondents are between the age group of 25 to 34 years, 27.5% of respondents are 35 to 44 years, and 10% of the respondents are between the age group of 45 to 55 years**.**

Table 2.
Table showing the Gender of the Respondents

S. No	Gender	No. Of. Respondents	Percentage (%)
1	Female	25	20.8
2	Male	95	79.2
Total		120	100

Source: Primary Data

The above table shows that out of 120 respondents taken for the study,79.2% of the respondents are male and 20.8% of the respondents are female.

Table 3.
Table showing the Occupation of the Respondents

S. No	Occupation	No. Of. Respondents	Percentage (%)
1	Private employee	56	46.7
2	Government employee	21	17.5
3	Professionals	18	15
4	Business	25	20.8
Total		120	100

Source: Primary Data

The above table shows that out of 120 respondents taken for the study, 46.7 % of the respondents are private employees, 20.8% of the respondents are Business, 17.5% of respondents are Government employee and 15% of the respondents are doing Professionals.

Table 4.
Table showing the Monthly Income of the Respondents

S. No	Income	No. Of. Respondents	Percentage (%)
1	Below Rs.50,000	12	10
2	Rs 50,001 – Rs 60,000	23	19
3	Rs 60,001 – Rs 70,000	30	25
4	Above Rs.70,000	55	46
Total		120	100

Source: Primary Data

The above table shows that out of 120 respondents taken for the study, 46% of the respondents' monthly income is above Rs.. 70,000, 25% of the respondent's monthly income is Rs.60,001 – Rs.70,000, 19% of the respondent's monthly income is between Rs.50,001 – Rs.60,000 and 10% of the respondent's monthly income is Below Rs.50,000.

Table 5.
Table showing the Insurance Awareness of the Respondents

S. No	Awareness	No. Of. Respondents	Percentage (%)
1	Yes	85	70.8
2	No	35	29.2
Total		120	100

Source: Primary Data

The above table shows that out of 120 respondents taken for the study, 70.8% of the respondents are aware ofeco-logical bricks, and 29.2% of the respondents are not aware ofeco-logical bricks.

Table 6.
Table showing the Sources of Awareness of the Respondents

S. No	Source of Awareness	No. Of. Respondents	Percentage (%)
1	Engineer	85	70.8
2	Advertisement	15	12.5
3	Friends / Family	20	16.7
Total		120	100

Source: Primary Data

The above table shows that out of 120 respondents taken for the study,70.8% of the respondents are aware ofeco-logical bricks through an engineer and 16.5% of the respondents are aware ofeco-logical through friends/family 12.5% of the respondents are aware ofeco-logical through advertisement.

Table 7.
Table showing the Preferences towards eco-logical bricks

S. No	Bricks	No. Of. Respondents	Percentage (%)
1	Gent waste bricks	40	33.3
2	Fly ash bricks	45	37.5
3	K-BRIQ	35	29.2
Total		120	100

Source: Primary Data

The above table shows that out of 120 respondents taken for the study,37.5% of the respondents prefer fly ash bricks and 33.3% of the respondents prefer Gent waste bricks, and 29.2% of the respondents prefer K-BRIQ.

XII. SUGGESTIONS

To promote the wider adoption and long-term success of ecological bricks, a multi-pronged approach involving technological innovation, economic incentives, policy frameworks, and public awareness is essential. Suggestions collectively emphasize the need for a holistic approach that not only addresses the technical aspects of ecological brick production but also ensures economic feasibility, policy backing, and social acceptance.

XIII. CONCLUSION

The construction sector, while essential for economic growth and urban development, is also one of the largest contributors to environmental degradation through its heavy reliance on natural resources, energy-intensive processes, and waste generation. In this context, ecological or eco-friendly bricks emerge as a practical and impactful solution that addresses multiple sustainability challenges simultaneously. By incorporating recycled materials such as fly ash, construction and demolition waste, plastic, agro-waste, and other industrial by-products, these bricks not only divert large volumes of waste from landfills but also reduce dependence on virgin resources like clay and cement, which are depleting rapidly in many regions.

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WEB RESOURCES

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- https://urbannext.net Gent waste brick: Reducing the construction embodied carbon
- http://www.researchgate.net Customer satisfaction in construction
- https://jeas.springeropen.com Optimization of plastic waste integration in cement bricks
- https://www.researchgate.net Brick-by-brick: Can we use plastic's second life to build a sustainable India?
- https://www.researchgate.net
- https://scholar.google.com
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