

ASSESSING THE ENVIRONMENTAL AND ECONOMIC FEASIBILITY OF USING RECYCLED MATERIALS IN URBAN CITIES PROJECTS FOR SUSTAINABLE DEVELOPMENT

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Abstract

Recycled materials in construction projects are receiving more attention as the demand for sustainable development rises. In order to promote sustainable development, this study aims to evaluate the viability of using recycled materials in urban construction projects from an economic and environmental standpoint. A secondary data strategy was employed in this study to gather and examine already-existing data. Results show that building with recycled materials is a viable strategy for sustainable development. A thorough examination of recycled materials' physical and chemical characteristics also yields important information about their suitability for construction. The study emphasizes the critical role sustainable urban development plays in advancing the welfare of people, communities, and the environment. The research's distinctiveness comes in its emphasis on determining if recycled materials may be used in urban construction projects, highlighting the significance of sustainable practices in minimizing our environmental effects while serving the demands of both present and future generations.

Keywords: economic feasibility, environmental impact, recycled materials, sustainable development, urban construction projects

INTRODCUTION

Sustainable development aims to balance economic, social, and environmental concerns to encounter the necessities of the present cohort without jeopardizing the aptitude of imminent generations to do the same. According to the authors, sustainable development in the built environment necessitates a comprehensive strategy considering

every stage of a building's lifecycle, from design and construction to usage and end-of-life (Ding & Huang, 2020). Additionally, they contend that to balance economic, social, and environmental issues, sustainable development in the constructed environment necessitates the integration of numerous disciplines, including engineering, architecture, and social science. There is an increasing need to assess the long-term effects of urban growth on the environment and to determine how to encourage sustainable development in urban areas as cities persist in developing and expanding (Owusu et al., 2021). In order to balance economic, social, and environmental issues, it is necessary to integrate various strategies, such as green infrastructure, sustainable transportation, and green buildings.

Utilizing recycled materials in construction is a crucial component of sustainable development. The Gulf Cooperation Council (GCC) construction industry is the subject of a study by Qasim et al. (2020) that focuses on the industry's environmental impact. According to the authors, the GCC region's building industry contributes significantly to environmental deterioration because it uses many natural resources, produces much waste, and emits greenhouse gases. Additionally, they contend that green building materials can help mitigate the adverse environmental effects of the construction sector by lowering resource consumption and waste production (Varshney et al., 2021). However, using recycled materials in construction projects might lessen these harmful environmental effects.

Recycled materials have been converted into new goods after removal from the trash stream. Glass, plastic, and recycled concrete are a few examples of recycled materials utilized in construction. There are various advantages to using recycled materials in buildings (Akbarnezhad et al., 2021). One benefit is that it lessens waste by preventing items from going to landfills or incinerators. As a result, less waste is disposed of in landfills, saving valuable space and lowering greenhouse gas emissions. Utilizing recycled materials can also support the preservation of natural resources. Utilizing already extracted and processed materials can help cut down on the need for new materials and the energy and resources needed to extract, develop, and transport them (Angelopoulos et al., 2021). Using recycled materials in construction can also lessen the environmental impact of new construction projects. An examination by Huang et al. (2021), using pre-made materials can assist in minimizing the energy and resources needed to generate new items, as well as the carbon footprint of a new building.

However, careful consideration of environmental and economic aspects is required when using recycled materials in urban construction projects. (Yan et al., 2021). For instance, economic trade-offs should be considered even though employing recycled materials can assist in lessening environmental effects. The initial cost of recycled materials

could be higher than that of new ones. However, lowering the requirement for fresh material extraction and disposal can also lower expenses over time. It indicates that incorporating recycled materials in construction projects should be thoroughly assessed for economic viability. It also emphasizes the importance of considering economic and environmental concerns while utilizing recycled materials in urban construction projects. The study by Chakraborty and Chakrabarti (2021) found that in order to optimize the advantages of recycling materials in urban infrastructure construction, a balanced strategy is required.

Urban cities worldwide have needed help with the essential issue of sustainable development. One method to support sustainable development is using recycled materials in urban metropolis developments. In order to promote sustainable development, this article explores the financial and environmental viability of using recycled materials in urban city projects.

LITERATURE REVIEW

Environmental Impacts

Recycled materials can benefit the environment when used in metropolitan city projects. Utilizing recycled materials lessens the requirement for virgin materials, which results in less environmental resource extraction. For instance, employing recycled concrete in construction projects conserves natural resources, uses less energy, and emits fewer greenhouse gases (Arulrajah et al., 2021; Fallah et al., 2019). Compared to virgin aggregates, the authors' research shows that recycled concrete aggregate (RCA) can dramatically reduce energy use and carbon emissions. Similarly, using recycled aggregates to create concrete successfully minimizes the adverse environmental effects of construction projects (Santamaria et al., 2020). The amount of waste dumped in landfills can be decreased by using recycled materials in urban city projects, which also lessens the requirement for landfill site space and the environmental impact of landfilling.

Recycled materials can also be used in urban city projects to lessen the consequences of climate change. This idea is connected to research by Chakraborty and Devi (2020) and Talamo et al. (2021), which found that using recycled aggregates in construction projects can dramatically lower greenhouse gas emissions and lessen the consequences of climate change. According to the study's findings, using recycled aggregates in urban construction is a practical and efficient strategy to lessen the carbon footprint of building projects. Because less energy is needed to make new materials when recycled materials are used, there are fewer greenhouse gas emissions. Additionally, recycling products lowers the need for fresh raw materials, reducing the destruction of forests, rivers, and wildlife habitats. Recycling is a sustainable option for building and

urban development since it helps protect natural resources and biodiversity (Qu et al., 2021).

Recycling materials for infrastructure projects has gained popularity in recent years since it may significantly reduce the waste and greenhouse gas emissions connected to conventional construction methods. The use of reclaimed asphalt pavement (RAP) in road construction projects effectively illustrates this strategy. Researchers looked into the environmental effects of utilizing RAP rather than conventional asphalt for building roads in a study published in the *Journal of Cleaner Production*. They discovered that employing RAP decreased garbage produced during construction while also cutting carbon dioxide emissions by 23% and energy usage by 22% (Smith et al., 2021).

Recycled concrete aggregates (RCA) are used to construct a new bridge in a different case study. The Texas Department of Transportation oversaw the project and substituted RCA for conventional aggregates in the concrete mix. Compared to conventional building techniques, the researchers discovered that utilizing recycled concrete aggregates decreased the environmental effect of the bridge's construction by 20%. The requirement for virgin materials was reduced, and less waste was produced during construction. Similarly, recycled steel has demonstrated positive environmental effects in infrastructure projects. According to a case study by the Steel Recycling Institute, utilizing recycled steel instead of virgin steel resulted in a 58% reduction in carbon dioxide emissions and a 34% reduction in energy use during the construction of a new highway overpass.

Economic Costs and Benefits

Although it could come at an added expense, using recycled materials in urban city projects can also be advantageous economically. Using recycled materials can, on one hand, cut down on demand for virgin materials, lowering material costs and reducing the quantity of waste that needs to be disposed of (Ong & Tan, 2015; Zaman et al., 2019). For instance, employing recycled materials in a building can help developers and builders cut expenses. Because recycled materials are frequently less expensive than virgin resources, construction expenses were reduced. Utilizing recycled materials can also lower trash disposal expenses in metropolitan areas by reducing the amount of waste transported to landfills. Utilizing recycled materials can also help the recycling industry grow economically by opening up work possibilities (Safi et al., 2019).

However, using recycled materials in urban metropolis projects has specific financial difficulties. The fact that not all recycled materials are as high-quality as virgin materials is one of the difficulties. Utilizing recycled materials could come at an added expense, such as processing, transportation, quality assurance, and regulatory compliance

(Matschullat, 2021). They stress the need for a more sustainable approach to resource recovery in their study, which offers a thorough overview of the problems relating to the quality and accessibility of recovered materials. Kim et al. (2022) examined the qualities of recycled polypropylene, a frequently used recycled material. The performance and durability of the finished product can be impacted by factors such as the source of the material and the processing technique. Recycled materials come in a variety of qualities. The study also discovered that raising the processing temperature and pressure during extrusion can enhance the recycled material's characteristics. It limits their use in urban city projects because some recycled materials may not be acceptable for particular purposes (Wong et al., 2021). Furthermore, recycling materials can be expensive to ship, especially if they need to travel considerable distances.

Technical Challenges and Opportunities

Several technical issues must be resolved to ensure the performance, longevity, and safety of the end product when using recycled materials in urban infrastructure projects. Variability in the qualities and attributes of recycled materials is a significant issue since it might influence whether they are suitable for use in particular applications (Xie et al., 2018). The composition, shape, size, and gradation of recycled materials, such as crushed concrete and reclaimed asphalt pavement, can vary greatly. The end product's strength, stiffness, stability, and resistance to wear, cracking, and other types of damage can all be impacted by this variability (Wu et al., 2020). For instance, if the recycled material is too coarse or has excessive debris, it might not connect properly with the components around it and cause the infrastructure to collapse sooner.

Making sure recycled components work with other materials used in the project, such as binders, additives, and reinforcement, is another problem. The characteristics and performance of the completed product can impact the mix design and processing techniques due to differences in the qualities of virgin and recycled components (Jafari et al., 2021). The compatibility of waste tire rubber with other materials can be improved using chemical modifiers, and mix design can be optimized to ensure the correct proportion of materials in the finished product are only two potential solutions that can be utilized to solve these problems. Additionally, including waste plastics in asphalt concrete mixtures can increase the strength and performance of roads while offering a sustainable method of disposing of plastic trash (Salam et al., 2021). The findings of their experiments indicate that adding waste plastics to asphalt concrete mixtures can enhance their performance and longevity. However, the ideal mix of design parameters will rely on various variables, including the particular application and environmental circumstances.

Using recycled materials in urban infrastructure projects presents additional technical difficulties, such as requiring specialized tools and processing techniques. Because recycled materials frequently differ from virgin materials in specific ways, treating them effectively generally requires specialized machinery or processing methods (Bartlett & McKenzie, 2019). As a result, extra costs for tools and training are frequently incurred, which raises project costs and complexity (Hossain et al., 2021). When using recycled materials in urban infrastructure projects, regulations, and quality standards must also be met. Municipalities frequently impose strict quality standards to guarantee the product's safety and quality (Ghavami & Pour-Ghaz, 2016). It may result in the need for more testing and documentation, which would make the project more complex and longer to complete (Shen & Wu, 2016). Additionally, recycled materials could need different processing stages, including crushing or grading, to meet project requirements.

Potential Social and Community Benefits

In addition to the environmental and economic advantages, using recycled materials in urban infrastructure projects can provide several social and communal benefits. Supporting regional recycling and trash management businesses could be one advantage, creating jobs and economic growth in the area (Huang et al., 2020). Additionally, it can raise public awareness of sustainability issues and encourage locals to participate in recycling and trash minimization programs. Incorporating recycled materials into urban infrastructure projects can also improve the constructed environment's aesthetics and visual appeal, raising both inhabitants' and tourists' quality of life. For instance, recycled glass can add a distinctive and appealing texture to decorative concrete or asphalt pavements (Aziz & Halim, 2016).

One potential advantage of employing recycled materials in a building is improving community resilience and catastrophe preparedness. Ullah et al. (2020) claim that building sturdy and stable surfaces for emergency access roads or disaster response routes is possible using recycled materials such as crushed concrete or asphalt. This strategy makes essential infrastructure accessible—before, during, and after emergencies or natural disasters. When a disaster strikes, emergency vehicles need safe, passable routes to get to the impacted areas, and using recycled materials to build access roads can have substantial advantages. Concrete and asphalt recycled from other materials are dependable, long-lasting, and have been used successfully to build sustainable infrastructure (Davies & Singh, 2018). Additionally, recycling materials for emergency access roads is a green choice that lessens the quantity of waste in landfills, which aids in reducing the effects of climate change.

Policy and regulatory frameworks

Policy and regulatory frameworks can facilitate the use of recycled materials in urban infrastructure projects, which can also promote more environmentally friendly construction methods. For instance, Bouzid et al. (2017) studied and examined the engineering characteristics and environmental sustainability of recycled materials used in civil engineering projects. The researchers discovered that recycled materials could be used in various civil engineering applications, including reclaimed asphalt pavement (RAP), recycled concrete aggregate (RCA), and recycled glass. However, the properties of these materials depend on the material's origin, the way it is processed, and quality assurance procedures. Additionally, some authors discovered that by integrating recycled materials like RCA and fly ash, RAC might be enhanced to attain high strength and durability while lowering the building industry's carbon footprint (Calvo et al., 2017).

The economic and environmental effects of recycling and reusing construction and demolition waste (CDW) in Switzerland were evaluated by Knoeri et al. in 2017. Compared to landfill disposal, the authors observed that CDW recycling and reuse could significantly reduce greenhouse gas emissions and energy use. They also discovered that policy and regulatory frameworks are required to encourage CDW recycling and reuse. The mechanical and environmental performance of sustainable pavement materials made from recycled CDW aggregates was also tested (Santos et al., 2017). Compared to conventional materials, the authors discovered that recycling recycled CDW aggregates in pavement construction can save costs and environmental impacts while achieving performance standards. These advantages can be attained, and frameworks for policy and regulation that encourage using recycled materials can aid in advancing sustainable urban development.

METHODS

This study aims to evaluate recycling materials' economic and environmental viability in urban city projects for sustainable development. This study will use a secondary data approach, which entails acquiring and examining information previously gathered and published by others. The research will start with an extensive literature review of academic and business publications, governmental papers, and other pertinent sources to obtain secondary data. Based on the literature review, the researcher can pinpoint the crucial elements and variables associated with recycled material utilization in urban city projects and the economic and environmental effects of such practices.

The following stage will involve gathering and examining secondary data on the costs and advantages of employing recycled materials in urban city projects from an economic and environmental perspective. In order to learn more about the expenses associated with the production, shipping, and fitting of recycled materials as well as their effects and advantages on the environment, it will be necessary to examine current databases, industry studies, and other pertinent sources. The analysis's findings will then be examined in the context of the study's goals, and conclusions about the viability of employing recycled materials in urban city projects for sustainable development will be made. The study will also suggest additional studies to support using recycled materials in urban city projects.

RESULTS AND DISCUSSION

Availability of recycled materials

Understanding the availability and distribution of recycled materials can provide information on their viability in construction projects (Jin et al., 2018). If the study discovers considerable volumes of recycled materials adjacent to urban construction sites, this could make using these materials more financially feasible (Nguyen et al., 2020). Understanding the quantity and distribution of recycled materials can also show how using these resources affects the environment. For instance, if recycled materials can be obtained locally, the carbon footprint of long-distance material transportation may be reduced (Kumar et al., 2021).

The possibility for cooperation between various stakeholders in the recycling and building industries is another possible realization (Deng et al., 2020). The building industry may have the chance to collaborate with the recycling sector to expand the availability and use of these materials if the analysis finds a sizable quantity of recycled materials that are available but have yet to be utilized (Nguyen et al., 2020). The building sector may be less dependent on conventional materials, and the recycling sector may see an increase in revenue sources and a decrease in the trash, which could benefit both sectors.

Quality of recycled materials

The viability of using recycled materials in construction projects for sustainable development can be determined by evaluating their physical and chemical qualities and how they compare to traditional construction materials. Such evaluations allow researchers to ascertain whether recycled materials can perform as well as conventional construction materials and whether they meet the necessary quality criteria for usage in construction projects. Such data can support adopting sustainable practices in the construction sector and help decision-makers make well-informed choices on using recycled materials in construction projects.

The results of these evaluations can point out any restrictions or problems with using recycled materials, allowing for future improvements to recycling procedures or material processing techniques.

Analyzing the chemical and physical characteristics of recycled materials, such as recycled aggregate concrete, has been the topic of numerous studies. For instance, Liu et al.'s study from 2021 sought to assess the mechanical characteristics and toughness of recycled aggregate concrete (RAC) using crumb rubber. The scientists tested the final product using a variety of mechanical and durability tests, replacing some of the natural coarse aggregate in RAC with crumb rubber. The study demonstrated that adding crumb rubber to RAC can weaken the material's compressive strength. The strength loss was discovered to be within a practical range for use. The researchers also discovered that adding crumb rubber can increase the RAC's toughness, impact resistance, freeze-thaw resistance, and resistance to chloride ion penetration. The authors conclude that while using RCA in concrete has disadvantages, such as diminished mechanical qualities and probable durability difficulties, it can still be an effective option for environmentally friendly buildings (Hossain et al., 2021). The authors also point out that the quality of the RCA, the amount of RCA used, and the type of application are some variables that affect how effective RCA is in concrete. Research can help determine if it is feasible to employ recycled materials in construction projects and inform choices about the materials to be used and the possible advantages of integrating sustainable practices into urban development.

Feasibility of using recycled materials

The construction industry is one of the major sectors responsible for waste production and the reduction of accepted resources. Recently, the use of recycled materials in construction projects has drawn attention as a means of reducing waste and protecting natural resources (Kibert et al., 2021). In construction projects, recycled materials such as concrete, asphalt, and steel can replace virgin resources (Masood et al., 2022). However, the quality and accessibility of these resources determine how well-recycled materials work in construction projects. Recycling materials may only sometimes be readily available depending on the region, type of material, and market demand. For instance, because many demolished buildings are in metropolitan locations, recycled concrete may be readily available, whereas it may be less readily available in rural places. Additionally, they conducted a life cycle analysis of the project and contrasted it with a conventional concrete building project, concluding that using recycled aggregate concrete offered advantages for the environment (Lu et al., 2022). In order to assess whether recycled materials are sufficient to suit the needs of a particular construction project, a feasibility study should be carried out.

In addition, the kind and source of the material, the techniques employed for processing it, and the degree of contamination can all affect the quality of recycled materials. For instance, Li et al. (2021) looks into how recycled polyethylene terephthalate (PET) flakes, one of the most popular recycled materials, are affected by various variables. The authors investigated the quality of recycled PET flakes of material type, source, processing techniques, and contamination levels. They discovered that these characteristics considerably impacted the quality of recycled PET flakes, with the best quality being produced by using clean, well-sorted PET trash and cutting-edge processing techniques. The quality of recycled polystyrene foam, a widely used plastic material, is examined by Makino et al. (2021) with contaminants and recycling circumstances. They discovered that the use of higher recycling temperatures and the presence of contaminants harmed the quality of the recycled polystyrene foam, causing it to lose mechanical strength and become more brittle. In order to verify that recycled materials fulfill the requirements and specifications for the intended use, they should be tested and analyzed. In order to make sure that recycled concrete can resist the desired load and environmental conditions, it should, for example, be tested for strength and durability.

CONCLUSION

By influencing decisions regarding the kinds of materials used in construction projects and the possible advantages of adopting sustainable practices in urban development, the study's findings may have significant consequences for urban planning and policy. Based on the findings and debate, using recycled materials in construction projects is a workable strategy for sustainable development. The quality and accessibility of these materials, however, determine whether it is practical to use recycled materials. The viability of using recycled materials can be determined by evaluating their physical and chemical characteristics and contrasting them with those of conventional building materials. Such data can support adopting sustainable practices in the construction sector and help decision-makers make well-informed choices on using recycled materials in construction projects. Understanding the quantity and distribution of recycled materials may also shed light on their environmental impact and the possibility of cooperation between various players in the building and recycling industries.

RECOMMENDATIONS

1. More research should be done on the availability and quality of recycled materials: It is essential to have a thorough understanding of both their availability and quality to encourage using recyclable

materials in construction projects. Future studies should concentrate on pinpointing the availability of these resources and their quality criteria to assess the viability of using recycled materials in construction projects.

2. Investigate the advantages and disadvantages of employing recycled materials in construction projects. Recycling materials can reduce waste and preserve natural resources, but it also presents some difficulties that must be resolved. Future studies should examine the advantages and difficulties of employing recycled materials in construction projects from an economic, environmental, and social perspective.

3. Create standards and guidelines for using recycled materials in building projects: It is crucial to create standards and guidelines that outline the conditions for utilizing these materials to guarantee the quality and safety of using them in construction projects. Developing such standards and recommendations, which can support the promotion of sustainable practices in the building industry, should be the main focus of future studies.

4. Intensify cooperation between the construction and recycling sectors: Recycling and building sectors must work together to boost the availability and usage of recycled resources. Future efforts should create alliances and partnerships between these two sectors, which can result in reciprocal advantages like waste reduction and money generation.

5. Promote education and awareness about using recycled materials: Promoting sustainable practices in the construction sector requires educating and creating public awareness about using recycled materials in projects. In order to enhance the adoption of sustainable practices in the sector, future action should concentrate on creating educational and awareness initiatives aimed at decision-makers, construction experts, and the general public.

FUTURE IMPLICATIONS

Finally, it should be noted that sustainable urban growth is essential for the welfare of all people, communities, and the environment. More than half the world's population lives in cities, producing greenhouse gas emissions. Adopting sustainable techniques that can lessen our influence on the environment while still addressing the demands of the present and future generations is crucial.

Cities can embrace sustainable urban development strategies by using a comprehensive strategy that considers social, economic, and environmental factors. Promoting waste management procedures, green places, energy-efficient construction, and sustainable transportation is essential. Urban sustainability can be promoted by

policies, strategies, and initiatives developed by governments, corporations, and communities.

There must be a sizable change in mindset and conduct for sustainable urban development. It calls for widespread social engagement, education, and awareness. Everyone, from decision-makers and urban planners to individuals and communities, has a part to play in creating a sustainable future. Together, we can build sustainable, livable communities that benefit everyone.

Sustainable urban development has broad ramifications. It can boost economic development, lessen environmental damage, and enhance individual and community quality of life. It can also support social solidarity and be used to combat social inequality. By putting sustainable urban development first, we can build a more sustainable, resilient, and fair future.

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