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Green building through reuse of waste material advancing sustainable development: an execution of Paris Agreement

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As the environment faces growing challenges, in 2015, the Paris Agreement committed nations around the globe to capping global warming at less than 2°C and striving for just 1.5°C instead. At its core, the agreement emphasizes the need for all sectors to work towards low-carbon, resilient societies. This study addresses the construction industry's significant waste generation and environmental impact. The research examines how green construction practices, specifically the reuse of waste materials, can align with the Paris Agreement's objectives, promoting sustainability and reducing environmental damage. It investigates design strategies for waste minimization and material reuse in green building projects to meet the Paris Agreement's objectives. This study will take an interdisciplinary approach that examines the Paris Agreement and current infrastructure laws, construction technology, and policy analysis to inform strategies to support policy-making and promote sustainable construction practices through green buildings and waste management systems and propose practical benchmarks for sustainable development. It explores challenges and opportunities in implementing these strategies across different regions through case studies and policy framework analysis. It aims to contribute relevant guidelines for waste management and the promotion of eco-friendly methods within the construction sector to support a low-carbon, resilient built environment.

Keywords: Environment, green buildings, Paris Agreement, sustainable development, waste management.

INTRODUCTION

The building industry is a major generator of waste, with vast quantities of materials being thrown away during construction, renovation, and demolition works. This not only poses environmental problems but also represents a missed opportunity for reusing resources. Against this background, the Paris Agreement provides a worldwide framework for combating climate change, which could inform research and policy-making on greener buildings and waste management. Nevertheless, how to use the Paris Agreement as a framework in this context is not clear; thus, there is a need to find out what works best when dealing with challenges and opportunities presented by green building through the reuse of waste materials across different regions and contexts.

This research seeks to enhance the comprehension of practicing the construction of green buildings by focusing on using the Paris Agreement as a guide. So, this research will look into various design strategies that aim to minimize waste as well as maximize their re-usage and discuss the persisting challenges and prospects that are associated with green buildings through the recycling of waste materials. Unlike existing literature that often examines green building and waste management separately or broadly references the Paris Agreement this study uniquely integrates these elements to address the practical challenges and opportunities of implementing the Paris Agreement in the construction sector. Certain case studies are analyzed with good examples to go deeper into the policy frameworks and regulations and relate to the environmental impact assessment, resilient design strategies, and future trends of the green buildings.

The objectives of this research paper are to establish proper design strategies that can be employed to attain minimum production of waste by promoting the reusage of material and waste within the green building projects and consider what is the best way we can use the Paris Agreement as an instrument to guide our investigation into green buildings along with waste management systems, and to set up certain benchmarks to have a good practice towards sustainable development informed by agreements reached under the Paris's Climate Change Conference – COP21. In light of these points, it hopes to promote more environmentally friendly methods and ways to create structures that also take a case about waste, therefore illuminating ways through which we can use the Paris Agreement as a guide for our inquiry in terms of the areas of our issues.

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The novelty of this work lies in its comprehensive examination of the subject matter, drawing data from different sources to provide practical implementation considerations for construction activities, and its specific focus on aligning green building practices with the Paris Agreement to promote sustainable waste management. This research goes beyond theoretical discussions by analyzing case studies, policy frameworks, and regulations to provide relevant and actionable guidelines for promoting sustainable practices in construction activities, contributing to a low-carbon, resilient built environment. The next sections and chapters will show an inclusive examination of this subject matter by drawing up data from different sources along with some case studies which shall put together the primary discoveries and the practical application considerations.

Statement of problem

The construction industry is one of the biggest waste producers, where large amounts of material are thrown out during construction, renovation, and demolition processes. However, this waste does not only pose environmental challenges but also represents missed opportunities for resource recovery. In the context of the Paris Agreement being a global framework for fighting climate change, it can be used as a reference point for green building research and policy development towards waste reduction. The application of the Paris Agreement as a framework in this respect remains unclear; hence best practices need to be identified that would address challenges and opportunities associated with green building through reusing waste materials across different regions and contexts.

Furthermore, there exist various design strategies aimed at minimizing waste generation while enhancing material reuse in green building projects, nevertheless, it is important to establish which ones work best and how they can practically be implemented to meet objectives stipulated by the Paris Agreement as well as promote sustainable construction industry development.

Therefore, this paper seeks to achieve several research objectives: finding out the most effective design strategies for reducing waste production in green buildings and enhancing material reuse; investigating whether or not the Paris Agreement would act as a guidepost in undertaking studies on sustainability within the built environment vis-à-vis waste management; looking into challenges and opportunities relating to eco-construction through recycling of rubbish materials within different regions so that relevant guidelines aligned with Paris accord may be developed. These are going to help in having a better understanding in terms of different methods that are to be followed for sustainable development by reusing waste material and setting up a benchmark for achieving sustainable development goals under the Paris Agreement.

Additionally, while dealing with these research questions; it is expected that such an undertaking will contribute significantly towards the promotion of sustainable practice methods during construction activities that have low impacts on the environment, especially those related to energy consumption efficiencies. Overall, this paper will explain the extent to which the Paris Agreement is or can be used as a guiding instrument in the construction sector to implement provisions about recycling waste into new buildings that are suitable for various climatic conditions.

Background and context

This research paper's background and context are about constructing green buildings through waste management. This aligns with the principles of sustainable development. It may also be linked to the Paris Agreement, which acts as a global framework for dealing with climate change. Since the construction industry is one of the biggest producers of waste, this topic continues to be relevant since it encourages environmental conservation by reusing such waste in environmentally friendly buildings.

The background portion gives an outline of what has previously been said or done on this topic, taking into account any pertinent historical information or literature reviews conducted by other researchers into related fields of study around waste reduction within buildings that are more durable than standard practice enables given the limited resources available at the moment while also taking into consideration the needs of future generations. As a result, the researcher first defines their research problem within these parameters before evaluating its importance concerning other studies that were conducted before along similar lines but have been either too general (e.g., *green buildings* without specifying whether residential, commercial, industrial, etc.) or too narrow (e.g., *insulation materials)*. Furthermore, the context includes methodical issues that are taken into consideration at the time of data collection, analysis, and interpretation as well as the beginning of the inquiry, such as a person's professional experience that piqued their curiosity and led to a wider investigation before a specific subject was chosen based on observations they made.

The research paper provides comprehensive information on the subject being discussed, including the problem statement's nature, historical context, and how it fits into the larger scheme of previous studies and research projects. By reviewing the relevant literature that identifies gaps and justifies the need for conducting research using a solid foundation from which useful ideas could emerge later during theoretical conceptualization stages designed towards obtaining overall goal(s) set up within it, the information provided is intended to help readers understand why the subject matter being studied is important within a broader field, thereby building credibility around investigation.

The issue of waste emergence in the building industry and its effects on sustainable development are discussed in this study. The main objective is to find design methods that can minimize the production of waste and promote the reuse of resources in the green buildings and construction sector. Along with this, this study also discusses and evaluates the potential of the Paris Agreement as a framework for research and policy development in this field by focusing on managing the waste that is produced in the process of construction. Finally, it also suggests certain practices for sustainable development that meet the requirements that are outlined in some of the International Conventions such as *the United Nations Framework Convention on Climate Change*.

The subsequent chapters and sections under this paper will provide an analysis of various issues relating to green buildings by discussing a few case studies that shall help in further implementations. The environmental impacts, Design Strategies, and Future trends and impacts shall also be covered in these chapters. All of these should significantly advance our understanding of sustainability in the construction industry and shed light on how to use the Paris Agreement as a guiding framework for waste management issues related to these buildings.

Significance of the study

This study is important as there is an increasing need and demand currently for sustainable buildings that are eco-friendly in terms of waste management. The construction industry contributes greatly towards the generation of waste if only those materials that have been wasted get utilized in making ecological structures, this will highly reduce the amounts of garbage being produced while promoting development that meets the present needs without compromising on the future generations ability to meet their own needs as well [1]. The aim of this research paper is thus twofold; firstly, it seeks to know what constitutes green practices vis-à-vis waste disposal methods, and secondly, its main focus is on how best we can use the Paris Agreement as our guide in achieving this.

This study is important because it examines design strategies for reducing waste while construction and explores the potential for material reuse in building construction, specifically in the context of environmentally friendly buildings through the reuse of waste materials. Furthermore, this analysis will include an examination of case studies and relevant illustrations to provide policymakers with knowledge of successful strategies implemented elsewhere, which they might then adopt. In addition, it is crucial not to overlook the importance of policy frameworks and regulations in ensuring strict adherence to rules governing various undertakings, such as technology and innovation, and economic and environmental analysis. These frameworks and regulations play a vital role in ensuring compliance by all parties involved Green Buildings Certification Inc. and U.S. Green Building Council (GBCI & USGBC). In addition, while evaluating the resilience design elements of a project against climate change effects in various places worldwide, environmental impact assessment reports should also take into account social sustainability factors. This is recommended by the International Organization for Standardization's Technical Committee 207, Sub-Committee on Environmental Management.

Additionally, it is necessary to implement education training programs, even though many individuals already possess substantial knowledge on these matters. However, there may still be a few remaining details that have not been thoroughly explored. These programs aim to raise awareness among the general public, particularly those residing close to upcoming green buildings, as their numbers continue to grow steadily as per Caux Initiatives for Business (CIB 2016) Conference. Finally, what does the future entail for us regarding these environmentally friendly buildings? Therefore, this research paper aims to uncover future patterns in sustainable building development, emphasizing the need to look ahead rather than dwell on the past.

The primary objective of this article is to improve sustainable waste management techniques in green construction, using the Paris Agreement as a guiding concept for research and policy development in environmental conservation within this field. The results of these studies can potentially inspire change among different participants in these activities, including industry stakeholders at national levels, local governments, and individual citizens who are

part of the global community and share the goals outlined in the Sustainable Development Goals (UNEP & RICS, 2013). Therefore, it is undeniable that conducting investigations into various aspects of waste recycling from the design stage to the completion of the construction process is of great importance. This is because we cannot sustain our way of life without developing more environmentally friendly homes, also known as green buildings. Therefore, all our actions must be consistently aimed at attaining sustainability, irrespective of the extent to which individuals comprehend the reasons for specific practices. Failing to do so would contradict the principles of "sustainable development" that align with the natural world.

LITERATURE REVIEW

Overview of green building and sustainable development

Green building and sustainable development are critical areas of research and practice in the construction industry. Green buildings aim to reduce the negative impacts of buildings on the environment and promote sustainable development. According to Teng, green buildings are designed to reduce operating costs by reducing energy consumption, but they can cost more than non-green buildings [2]. However, sustainable building materials, which are domestically created and sourced, can decrease transportation costs and carbon dioxide (CO_2) emissions, and they possess a lower environmental effect, are thermally effective, require less energy than conventional materials, make use of renewable resources, are lower in harmful emissions, and are economically sustainable.

The benefits of green buildings include environmental benefits such as enhancing and protecting biodiversity and ecosystems, improving air and water quality, reducing waste streams, and conserving and restoring natural resources. Social benefits include enhancing occupant health and comfort, improving indoor air quality, minimizing strain on local utility infrastructure, and improving overall quality of life. However, sustainable development is a crucial challenge, particularly in developed nations, and the environmental load of building materials has become a more significant requirement. Among the directions for solutions are new material applications, recycling and reuse, sustainable manufacture of products, or use of green resources such as reusing various industrial wastes like industrial by-products, demolition debris, plastic waste etc., to reduce CO_2 emissions, reduce landfill waste, lower costs and more as mentioned in Table 1.

Table 1. Various waste materials repurposed in construction.

Waste Material Type	Source	Application in Construction	Benefits	Challenges
Industrial By-products	Manufacturing, processing plants	Cement replacement (fly ash, slag), aggregate in concrete, road construction.	Reduced CO2 emissions, lower costs, improved durability of concrete.	Potential heavy metal contamination, inconsistent material properties, requires proper processing.
Demolition Debris	Building demolition, renovation	Recycled concrete aggregate (RCA), reclaimed wood, bricks, and other materials for new construction.	Reduced landfill waste, conserves natural resources, lower transportation costs.	Quality control, potential contamination (e.g., asbestos), requires sorting and processing, public perception.
Plastic Waste	Municipal solid waste, industry	Use as a partial replacement for cement or aggregates in concrete, production of plastic lumber, or as a component in asphalt mixes.	Reduces plastic waste in landfills, can improve the workability and durability of concrete and asphalt, lightweight.	Concerns about the long-term stability and leaching of microplastics, potential for increased flammability, requires proper pre-processing and mixing, limited acceptance by building codes and standards.
Tyre waste	Discarded vehicle tyre	Shredded tyre can be used as an additive to asphalt mixes, as a drainage layer in landfills, or as a component in lightweight concrete.	Reduces tyre waste, improves the flexibility and crack resistance of asphalt, provides good insulation and shock absorption.	Potential for leaching of chemicals, fire hazard, requires proper shredding and processing, limited applications in building construction.

Table 2. Novelty of work – Addressing gaps in existing literature

Area of focus	Existing literature	Novelty of this work
Green Building & Waste Management	Examines green building practices and waste management separately.	Integrates green building practices with waste management strategies under the framework of the Paris Agreement.
Paris Agreement Application	Mentions the Paris Agreement as a general framework for climate action.	Investigates the specific application of the Paris Agreement as a guiding instrument for green building and waste management systems, establishing benchmarks for sustainable development.
Design Strategies & Material Reuse	Discusses design strategies for waste minimization and material reuse in green building projects.	Aims to identify the most effective design strategies and their practical implementation to meet objectives stipulated by the Paris Agreement, promoting sustainable construction industry development.

The concept of sustainable building has been studied extensively in the literature. Shen investigated the green building industry in Thailand, while Shen developed an integrated system of text mining techniques and case-based reasoning (TM-CBR) to support green building design [3]. Wang in 2022 researched the impact path of the sustainable development of green buildings in China [4]. However, there are gaps in existing literature, such as integrating green building practices with waste management strategies and identifying the most effective design strategies according to the Paris Agreement framework. This work focuses on and discusses these gaps as summarized in Table 2.

In summary, green building and sustainable development are critical areas of research and practice in the construction industry. Green buildings aim to reduce the negative impacts of buildings on the environment and promote sustainable development. Sustainable building materials, which are domestically created and sourced, can decrease transportation costs and CO_2 emissions, and their power environmental effects are thermally effective, require less energy than conventional materials, make use of renewable resources, are lower in harmful emissions, and are economically sustainable. The benefits of green buildings include environmental benefits such as enhancing and protecting biodiversity and ecosystems, improving air and water quality, reducing waste streams, and conserving and restoring natural resources. Social benefits include enhancing occupant health and comfort, improving indoor air quality, minimizing strain on local utility infrastructure, and improving the overall quality of life, as shown in Figure 1. However, sustainable development is a crucial challenge, particularly in developed nations, and the environmental load of building materials has become a more significant requirement. Among the directions for solutions are new material applications, recycling and reuse, sustainable manufacture of products, or use of green resources.

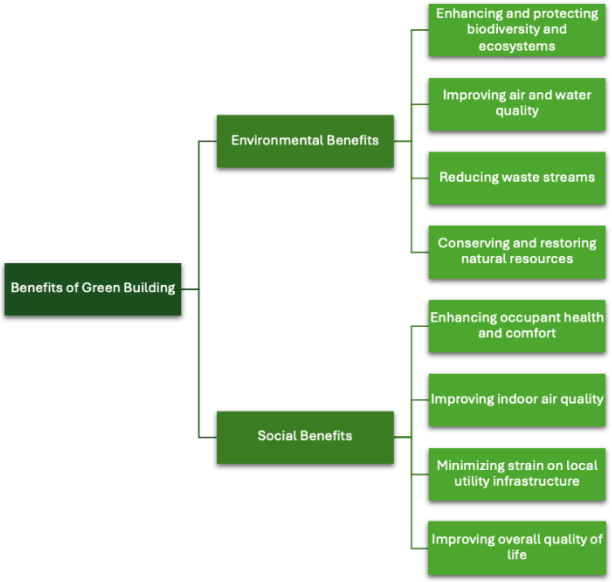

Figure 1. Benefits of green building

The Paris Agreement and its connection with sustainable buildings

The Paris Agreement is a global campaign to mitigate climate change by reducing greenhouse gas emissions. This also has huge implications for the fore construction industry, mainly in sustainable architecture and waste management. Construction is responsible for a notable amount of CO_2 produced into the atmosphere, which amounts to 39% of the total CO_2 emissions in the USA [5].

Green building is one vital element of sustainable development that seeks to reduce the effects on the environment while enhancing people's lives through resource conservation and overall improvement in quality of living [5]. Though not a new concept, green buildings have gained more prominence recently due to their contribution towards mitigating climate change effects which were found harmful indeed. To attain the worldwide reduction objective, the Intergovernmental Panel on Climate Change (IPCC) emphasizes the necessity of swift changes in the construction, energy, and transport sectors. Commercial buildings and residential facilities

provide approximately 40% of global carbon emissions associated with energy consumption [6], as shown in Figures 2 and 3.

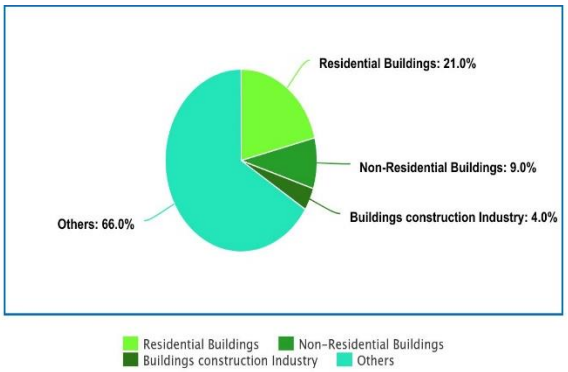

Figure 2. Energy consumption in 2022 (open access, doesn't require copyright permission).
Source: Adapted from Global Alliance for Buildings and Construction, Global Status Report for Buildings and Construction (2023)

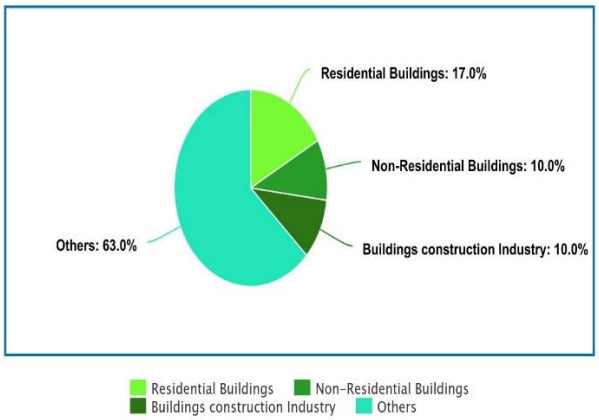

Figure 3. Global energy and process emissions in 2022 (open access, doesn't require copyright permission).
Source: Adapted from Global Alliance for Buildings and Construction, Global Status Report for Buildings and Construction (2023).

The principles underlying the design of green buildings aim to greatly reduce resource usage, thereby optimizing energy consumption, preserving and safeguarding water, optimizing space utilization and material usage, and improving indoor environmental quality, among other factors. Additionally, operations and maintenance practices are also optimized. For example, the impact of global warming can be reduced by utilizing sustainable materials like LEED recessed access doors while simultaneously ensuring the safety of workers on a global scale [6].

To achieve the ambitious targets outlined in the Paris Agreement, it is imperative to involve important stakeholders such as the construction sector. Without their participation, these goals cannot be effectively accomplished. Implementing eco-friendly construction methods and utilizing reusable resources will effectively reduce the carbon footprint of building projects and make significant contributions towards achieving sustainability objectives. Furthermore, these strategies facilitate endeavors to adjust to climate change.

In summary, the Paris Agreement possesses the capacity to influence different sectors of the economy, namely those about construction, such as environmentally conscious building and waste management. By embracing this viewpoint, individuals can establish systems that are sustainable to the environment, as they understand their obligation to reduce the effects of global warming. In essence, we must utilize all accessible resources to save planet Earth, as even the most minor efforts have a substantial effect on conserving nature for future generations to come [4].

DESIGN STRATEGIES FOR WASTE REDUCTION AND REUSE OF RESOURCES

Overview of strategies for sustainable design in buildings

Some good ways to reach the goal of getting zero waste is by following construction methods like prefabricated construction or modular construction, which will use the resources in the best way for building projects. One of these methods is using pre-made parts during the building process to cut down on waste and make the work go faster and better. The building will cost less in the long run because it can be quickly changed for different uses without doing much damage. This makes the buildings last longer [7].

Adaptive reuse is the process of finding new uses for old buildings or materials instead of making new ones. This saves energy and reduces waste by cutting down on the production process. It also makes sure that cultural and historical values connected to historic buildings are kept alive, which could be lost forever if people involved in demolition activities aren't aware of them [8]. This is very important because of the many reasons why people are still trying to protect these buildings, which are well-known around the world among experts who study how people settled in different parts of the world over time. This includes archaeologists whose job it is to study ancient civilizations from all over the world, especially those that lived along major rivers, like the Nile River Valley Civilization in Egypt, the Indus Valley Civilization in India, and the Yellow River Valley Civilization in China. By taking care of these buildings, they are being saved for future generations to use as examples of what not to do and how to avoid making the same mistakes again.

As part of a waste management strategy, waste management plans are made during the planning phase to make the processes of collecting, sorting, reusing, or recycling as efficient as possible by following the waste management hierarchy as shown in Figure 4, where prevention of wastage is the top priority followed by reducing, reusing, recycling the waste and so on. Along with it, it also includes ways that are safe to dispose of unnecessary waste. Waste Management is very important to save resources, and it also promotes eco-friendly practices in the construction industry. It reduces wastage and makes sure that everything is properly managed without its entire life cycle. Therefore, including waste management strategies like waste minimization planning, onsite sorting and recycling, and prefabrication in the construction sector as discussed in Table 3 is necessary.

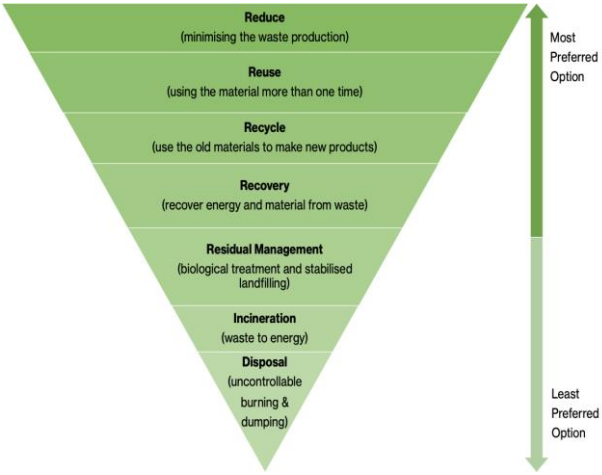

Figure 4. Waste management hierarchy

Table 3. Waste management strategies in construction

Strategy	Description	Benefits	Challenges
Design for Disassembly	Designing buildings to be easily disassembled for reuse or recycling of components.	Reduces demolition waste, facilitates material recovery, promotes circular economy.	Requires careful planning and design, may increase initial costs, requires skilled labor.
Waste Minimization Planning	Developing a plan to reduce waste generation during construction through efficient material use.	Reduces waste disposal costs, conserves resources, improves project efficiency.	Requires commitment from all stakeholders, may require changes to standard practices.
On-Site Sorting & Recycling	Sorting construction waste on-site for recycling or reuse.	Reduces landfill waste, generates revenue from recycled materials, promotes environmental awareness.	Requires space and labor, potential contamination of materials, market availability for recycled materials.
Prefabrication	Manufacturing building components off-site in a controlled environment.	Reduces waste, improves quality control, speeds up construction.	Requires careful planning and coordination, transportation costs, limited design flexibility.

Case studies/Best practices

Case studies are real-life examples that can be used to show how materials are used efficiently and methods for reducing waste are put into practice in green building projects. They give real-life cases that help make these ideas clear. Let me show you what I mean. The Edge is the name of an office building in Amsterdam that is made to be great for the environment. The building can reach a very high level of sustainability by using methods to save energy and water and programs to reuse building materials. This makes sure that the people who live there can enjoy both comfort and sustainability. In Seattle, there is a business building called the Bullitt Center [9], which is another example. Because it uses green design concepts, this building has reached net-zero energy use. Gathering rainwater, using natural ventilation methods, and using a lot of recycled materials are some of the things we do. The Renewal Workshop is in Oregon, United States of America. People bring their old clothes to this business to have them fixed up and then sell them again. This is an explanation of how the fashion business can use the circular economy idea to become more environmentally friendly.

One of the examples of sustainable waste management policy is performing audits on waste streams to establish preliminary measurements and to identify the chances of diverting them. The Energy Research Institute (TERI) in Bangalore, India, is one example of an organization that uses sustainable design concepts like passive cooling and heating to reduce energy usage. This building is situated on an axis that runs from east to west to the northern side to have glare-free light. It also has the dale cavity wall on the south side for the insulation. It has an open atrium space with skylights to increase

the natural light. It also has an earth air tunnel system for efficient cooling and heating.

Another case includes an office building located in Athens, which has shown that the installation of a green roof for sunshade has resulted in a reduction of 19% of the energy that is consumed, which is used for cooling purposes, Also, there is *The Indira Paryavaran Bhawan* in New Delhi, India which is a building that has a net-zero energy building (NZEB) which shows an important leap from the usual traditional building designs. The team of this project has focused on certain initiatives to decrease the usage of energy by employing a few measures like increasing the natural light, which includes shading and garden landscaping to decrease the temperatures outside and also by using active building systems which are energy efficient. This building has achieved in reduction of 70% of the energy being consumed when compared to other traditional buildings. This has also been awarded a GRIHA 5-star rating and platinum rating from LEED [10].

PARIS AGREEMENT AS A FRAMEWORK FOR RESEARCH AND POLICY DEVELOPMENT

The Paris Agreement of 2015 is an important global treaty that aims to address climate change by reducing the emissions of greenhouse gases and promoting sustainable development. It provides certain guidelines and strategic plans for the countries to follow in mitigating climate change by encompassing various measures like promoting sustainable construction and waste management.

Understanding the Paris Agreement within the context of green building

The Paris Agreement represents a global framework for addressing climate change and its impacts with specific reference to green building and waste management among others. The construction industry accounts for large amounts of waste generation globally where significant quantities of materials are discarded during construction, renovation, or demolition worksites thereby creating environmental challenges in addition to lost opportunities for resource recovery. In this way, therefore, the Paris Agreement offers potential ways for research work as well as policy formulation on green buildings along with waste disposal methods.

The Paris Agreement acknowledges the significance of sustainable development and emphasizes the need for fully integrated actions to address global warming reduction. The articles of the agreement include measures to promote energy conservation through the use of green buildings, which involve the adoption of renewable energies and sustainable practices in the construction industry (UNFCCC Secretariat). It also emphasizes the importance of decreasing CO_2 emissions from buildings, which contribute to approximately 39% of worldwide energy-related CO_2 emissions. It calls for improving low-carbon resilient infrastructures and sustainable models.

All the countries can establish policies and measures to promote energy efficiency and the adoption of renewable energies for having sustainable building practices following a commitment to the Paris Agreement. These measures provide the requirements for using various appliances that are powered by solar panels, which help in electricity savings. In order to do such practices, they must be granted subsidies, grants, tax credits, etc., and other possible things to support them. For example, a few member states of the European Union have already implemented certain directives named the Energy Performance Building Directive (EPBD) and the Renewable Energy Directive (RED), which mandate the development of policies that improve the energy efficiency in the buildings and promote the usage of renewable energy. Another example is, that the United States has established the Green Building Council, which has certified around 50,000 environmentally friendly buildings. China has also established certain evaluation standards for constructing sustainable buildings that have appliances that use renewable energy and save energy.

The Paris Agreement establishes global guidelines for combatting climate change by raising certain initiatives like the development of sustainable buildings and waste management. Various governments can use this treaty as a foundation for making policies and implementing them to promote sustainable construction including energy saving and renewing.

Using the Paris Agreement for policy creation

The Paris Agreement acts as a global treaty that outlines certain actions that every nation must follow to generate carbon emissions. Regarded by numerous individuals as a highly significant document in the realm of environmental preservation, it is well recognized for its provision of explicit directives for action to be taken by nations worldwide.

The Paris Agreement serves as a framework for the advancement of research and the formulation of policies about change problems. One method it employs is the establishment of goals or targets that must be achieved in the context of sustainable development, among other objectives. For instance,

specific regulations can be implemented under the domains of green buildings and management of waste to align with and support efforts to mitigate global warming.

The governments may refer to sustainable building certifications as an organizing principle when developing national codes for construction methods that align with the goals of low-carbon economies, as outlined in international agreements like the United Nations Framework Convention on Climate Change (UNFCCC). One method of guaranteeing that new projects adhere to the legal norms could be to integrate them into the national building laws or even make them obligatory components within those regulations.

Carbon pricing systems are essential elements that must be included in the policy-making stage. They provide incentives for investing in energy-efficient technology with low emissions in the manufacturing sectors of developing nations, as described in Articles 6 and 7. These rules are supposed to promote sustainable production methods that help reduce carbon emissions from industries that burn fossil fuels to generate energy.

The collaboration between the public and private sectors is essential to policies that are necessary to have sustainable construction practices as this helps in facilitating the relevant information and promotes transformation in various sectors that are using green building techniques as per Article 11. This collaboration creates an environment that promotes sharing knowledge and implementation in terms of sustainable building technology. Finally, to have significant progress in the construction sector globally, we must follow the Paris Agreement in terms of creating a policy for the buildings. If all the countries align their policies with the international agreement, they can speed up their efforts in creating buildings with zero carbon emissions. This also makes a significant contribution to the global objectives laid down under the UNFCCC under classes 5 and 13, which address climate change.

CASE STUDIES ON GREEN BUILDING AND WASTE MANAGEMENT

What we learned from sustainable building projects

The sustainable building projects provide a framework to incorporate green buildings to have a sustainable construction process by aligning with the goals under the Paris Agreement. One such example of a sustainable building plan is a commercial structure named Bullitt Center in Seattle [9], which has been recognized as one of the most sustainable buildings in the world. Their effort shows various things such as a rainwater-to-potable water system, composting toilets, and rooftop solar panels, resulting in overall positive energy usage. It functions as a symbol for sustainable construction methods that help enhance our comprehension of carbon neutrality and promote the efficient use of resources.

Another example of sustainable buildings is the Empire State Building, which is located in New York. It has gone through a lot of major energy efficiency during the renovation process. Though all the sustainable goals were not fully achieved, it made a significant process through this project like installing new windows, upgrading the heating ventilation air condition systems, and the addition of insulation. This has resulted in a yearly reduction of power usage by 38%. This has also helped in saving the costs annually by $4.4 million on utility bills as per the USGBC.

Innovative strategies for waste minimization

The Zero Waste Research Center in San Jose is a notable institution where novel methods for waste reduction can be explored per the Paris Agreement [10]. Within this establishment, there is a material recovery station that conducts the separation and treatment of recyclable materials, as well as a composting site where organic waste is transformed into a superior-quality soil supplement. Therefore, this working prototype can serve as a model for sustainable waste management systems. It not only demonstrates the amount of waste that could be saved through recycling but also highlights the fact that we have not yet fully utilized all potential sources of renewable energy. If these sources are effectively harnessed, they might contribute significantly to the accomplishment of carbon neutrality.

The Green Demolition Project in Toronto shows an excellent approach by which the buildings are carefully demolished to ensure that the components that can be recycled and reused are extracted and used somewhere else. Mostly, these components are sold in the open market, while others are donated to local charities or non-profit organizations. This method successfully helps in diverting thousands of tonnes of waste from landfills. Moreover, it also provides beneficial options for builders who require particular types of materials for their various projects.

Examples that show successes through reuse of waste

Materials reuse success stories demonstrate the concepts of the circular economy, which aligns with the agreements made during the COP21 Conference

under the UN Framework Convention on Climate Change (UNFCCC). One of them is the *Habitat for Humanity ReStore* (Habitat for Humanity) [12], which gathers all the used or unwanted building supplies such as appliances and furnishings, processes them, and then sells them at affordable prices. This initiative has been helping in funding low-cost home projects that conserve resources and reduce the strain on the landfills by diverting these millions of tons of waste to places where they can be reused. This is a success story which has contributed to the sustainable development goals and efforts to mitigate climate change.

Sustainable development is an important concept in terms of green building through the reuse of waste. Its main objective is to achieve our present needs while protecting the quality of life of future generations. Sustainable waste management aims to minimize the waste streams and handle the resources efficiently with the use of recovery, recycling, reuse, and minimization of waste. The Leadership in Energy and Environmental Design (LEED) has a green building rating system that analyses the environmental performance of buildings in nine categories which also includes the materials and resources. The LEED includes waste management credits that mainly focus on various kinds of waste like construction waste, reusing materials, analyzing waste channels as well and successfully managing consumable and durable goods.

All these case studies and success stories regarding green buildings through waste management offer various important and valuable perspectives in terms of the ways to harmonize our practices under the goals laid down by the Paris Agreement. This can help us save a lot of resources and have proper waste management that shall help in reaching the sustainable development goals laid down in the Agreement.

ENVIRONMENTAL IMPACT ASSESSMENT OF GREEN BUILDINGS

The Paris Agreement is the most important agreement about the global climate and it aims to stop or reduce the global temperatures to less than 2°C in terms of pre-industrial levels, and it is striving to reduce the rise of the temperature to 1.5°C. The Environmental Impact Assessment (EIA) regarding Green Construction aims to analyze, control and reduce the negative impacts that the construction projects have on the ecological systems. The Life Cycle Assessment of the building materials and the measurements of carbon footprint, along with taking the biodiversity services into account, is important in terms of assessing the environmental impact of green buildings, which is in line with the goals of the Paris Agreement.

Life cycle assessment of building materials

To address the environmental impact, the Life Cycle Assessment (LCA) is used as an important tool. It analyses the product during its entire lifespan, beginning from the extraction of the raw material till the end of its disposal or recycling Assessment [13], as shown in Figure 5. So, to reduce their greenhouse gas emissions as per the principles laid down by the Paris Agreement, LCA should be encouraged, which will lead to Sustainable development [14].

The Life cycle assessment has different phases, which have a goal definition and scope setting that establishes its objectives to carry out the Assessment as shown in Figure 6. It has a system boundary setting that determines the limitations that are there and in which the Assessment of the functional unit and product system will be conducted. It has inventory analysis where the data will be collected on the inputs and outputs of the product systems, which includes their consumption of energy and the waste that is generated in the process of manufacturing. Impact assessment compares these data against predetermined values, such as global warming potential (GWP). Interpretation involves comparing all findings with relevant benchmarks while reporting and passing on this knowledge to stakeholders. For example, it displays the results obtained from determining the impacts caused by the use of certain types of building materials, along with recommendations for reducing them [15].

Carbon footprint analysis

Carbon footprint analysis assesses the efforts made by enterprises to reduce their detrimental emissions into the earth's atmosphere. The analysis encompasses all air emissions across the entire lifespan of building projects, with a particular emphasis on CO_2. This includes emissions from the extraction of raw materials, as well as the disposal or recycling of items at the end of their life cycle [16].

The construction sector has a significant impact on greenhouse gas (GHG) emissions, with concrete alone contributing to nearly 75% of the total embodied carbon in structures, while steel accounts for approximately 18%.

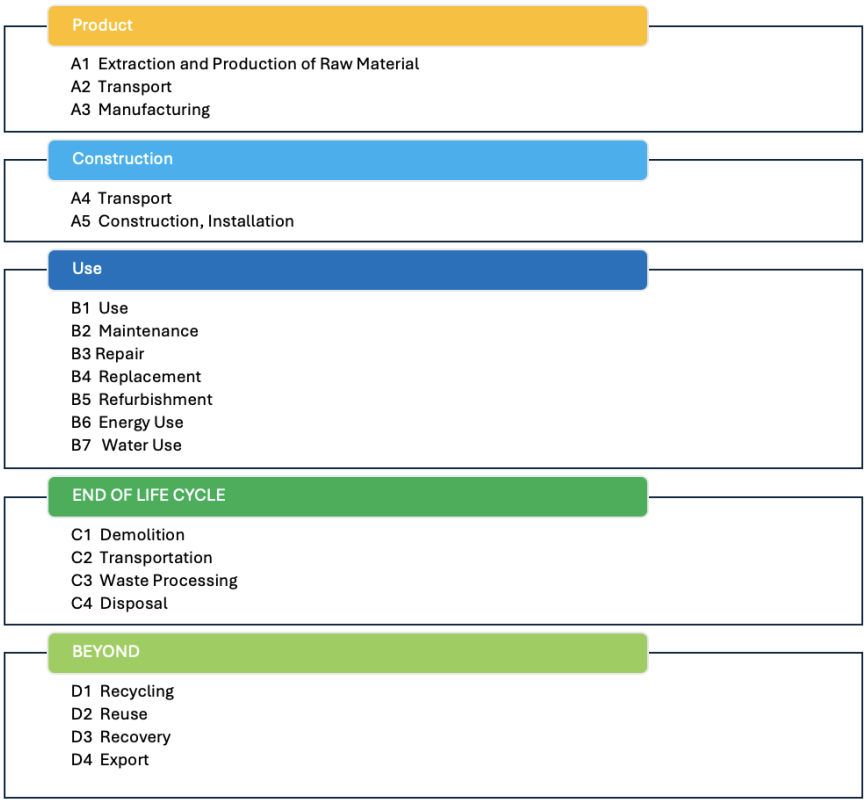

Figure 5. Life cycle stages of a building

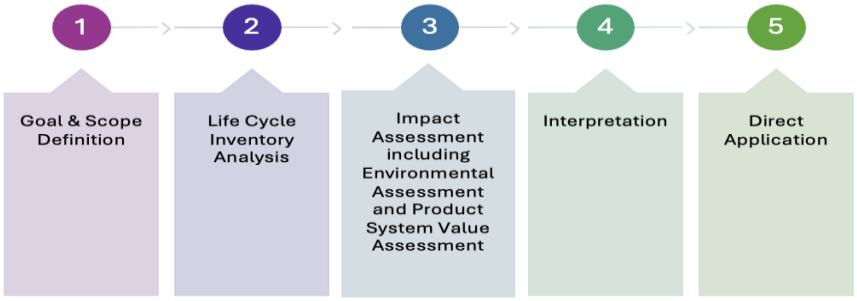

Figure 6. Phases of life cycle assessment

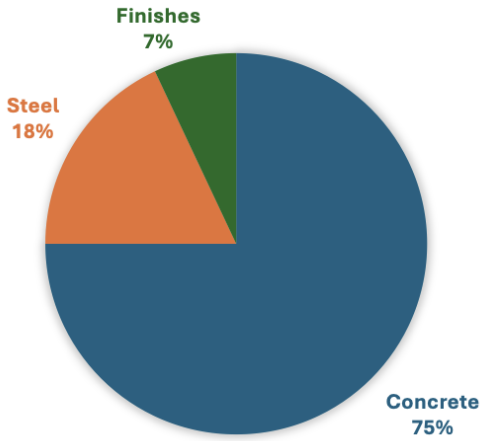

Figure 7. GHG Emissions by construction sector (prepared in this work)

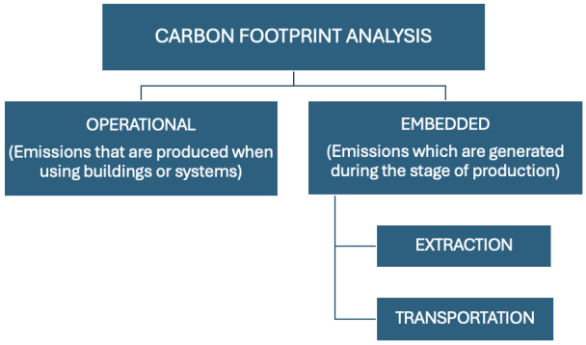

Figure 8. Carbon footprint analysis in construction industry (prepared in this work)

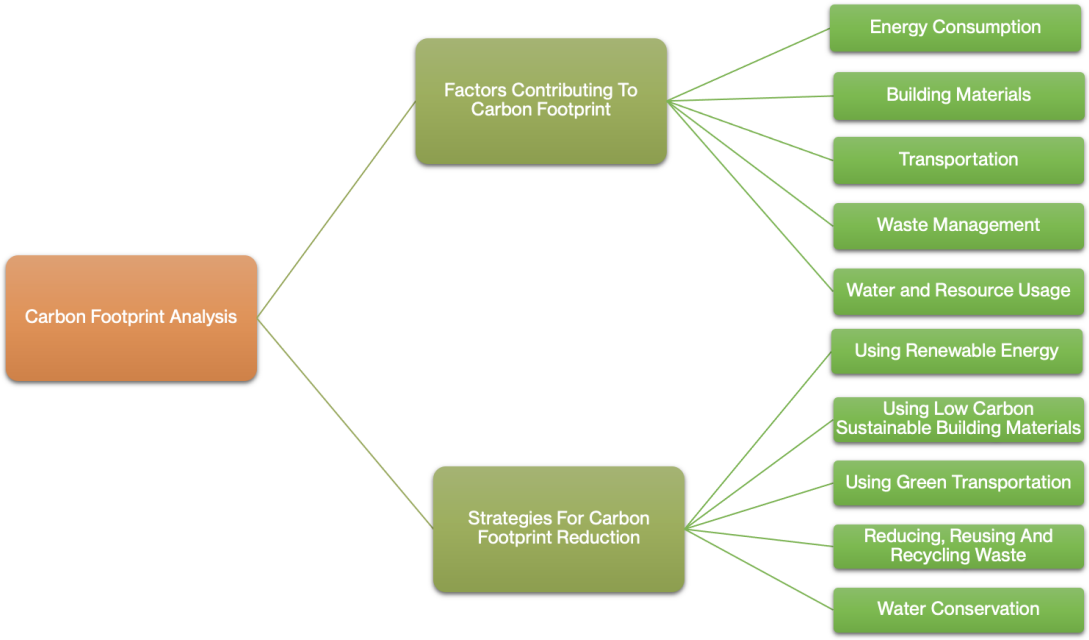

Figure 9. Carbon footprint analysis through factors contributing to carbon footprint of buildings and strategies for reducing them.

Finishes also have a substantial impact since they make up approximately 7%, as shown in Figure 7. Therefore, it is imperative to tackle these concerns as CO_2 emissions have a significant impact on climate change in the short term, making it a matter of urgency [17]. This method allows for the identification of building process stages that emit higher levels of carbon into the environment, facilitating the selection of building supplies with lower carbon content [16]. Carbon footprint analysis can be divided into two main categories: operational and embedded. The term *operational* refers to emissions that are produced when using buildings or systems, like heating systems. The other term, *embodied*, refers to those emissions that are generated during the stage of production, which includes activities like extraction and transportation [16], as shown in Figure 8. The factors that contribute to the carbon footprint of construction of buildings and the strategies to reduce carbon footprint in building operations are depicted in Figure 9.

It is important to conduct the carbon footprint analysis for green buildings to meet the lines that are outlined in the Paris Agreement, which lays down the reduction of greenhouse gas emissions and encourages sustainable development. Not only that, but this research will also help identify the areas that need enhancement. This facilitates the decision making which focuses on mitigating the adverse impacts on the environment and promotes better standards of living by reducing the levels of pollution to have a healthier planet [14].

So that it adheres to the agreement, the Inter-American Development Bank (IDB) has devised the "IDB Group Paris Alignment Implementation Approach" (PAIA). This approach assesses all new projects undertaken by the bank to ensure that they do not hinder the transition to low-carbon and climate-resilient economies, as outlined in the Paris Agreement. PAIA offers a systematic approach, a set of principles, and technical guidelines for evaluating various sectors, such as buildings. This evaluation helps in developing technological designs for

operations and facilitates communication between the organization and its customers.

POLICIES AND REGULATIONS REGARDING THE GREEN BUILDINGS

Green Buildings are very important to implement construction practices and to improve the environmental impact of the buildings. So, we need policies and regulations like national and international regulations and incentives for sustainable building practices along with compliance and enforcement strategies.

The International regulations provide a basis for the implementation of sustainable construction methods. LEED, as discussed earlier, is one of the leading green building rating systems in the USA. It assesses various factors like the efficiency in energy usage, conservation of water, and indoor air quality, starting from the design face throughout the construction process. Another regulatory framework is the International Green Construction Code (IGCC), which provides the minimum standards for sustainability in many areas like site development, energy conservation, water efficiency, etc.

In India, The Indian Green Building Council (IGBC) has been an instrument in improving the implementation of green building practices within India. It has the Green Building Rating Systems, which ranks the buildings based on their energy efficiency, water usage, material selection, and usage by preventing wastage of materials and resources and other factors. It gives certification to the buildings in different categories like Platinum, Gold, and Silver depending on their compliance with these criteria. Along with the IGBC, the Green Rating for Integrated Habitat Assessment (GRIHA) also plays an important role in checking whether the buildings comply with the green building criteria to promote sustainable construction. This acts as an incentive for the developers to adhere to sustainable practices in the building, have proper usage of resources, and minimize waste.

FUTURE TRENDS AND OUTLOOKS IN GREEN BUILDINGS

Innovations about to happen

The recently developed green building technologies are highly significant for achieving the goals of the Paris Accord and promoting environmentally responsible building practices. The article titled "Market Report on Green Buildings" examines important advancements that are expected to impact the future of environmentally sustainable construction methods. Employing eco-friendly construction technology is an astute strategy to preserve energy, enhance occupant comfort, and minimize environmental harm with equivalent work. This system enables the real-time monitoring and control of activities within buildings through the utilization of automation sensors and other modern technology. The main objective of this effort is to promote energy efficiency and sustainability.

Some people perceive biophilic design concepts in green architecture as a novel trend. The objective of biophilic design is to integrate natural elements, such as plants, sunlight, and water, into the architectural design of buildings. The goal is to improve the well-being of individuals while also promoting a stronger relationship with the natural world. By integrating these elements, green buildings can improve indoor air quality, reduce stress levels, and promote efficiency. The Paris Agreement prioritizes enhancing human well-being and protecting the environment, and this initiative aligns with both objectives.

Projected changes in policy and practice

The Paris Agreement came up to put the rise intending to temperature to less than 2°C. To achieve the goal it has laid down, the government has brought up certain changes in the green buildings by bringing up the Green Buildings Standards and Certifications. These standards, like LEED or BREEAM, require buildings to follow certain environmentally friendly rules from the time they are designed until they are finished. They also require buildings to be sustainable. Carbon pricing plans, like cap-and-trade or carbon taxes, will reward behaviors that produce less carbon, while behaviors that produce more carbon will be punished.

It is believed that partnerships between the public and private sectors will be very important in advancing green building technologies and methods. These partnerships help solve money problems while also encouraging new ideas and methods that are better for the environment. More money will likely be spent on research to improve green building technology by creating new materials, putting in place energy-efficient systems, and using design methods that have less of an impact on the environment and make buildings last longer.

Sustainable urban planning ideas should be incorporated into building plans and constructions. This will allow for the growth of green spaces, public transportation systems, and renewable energy sources in city infrastructures. Climate-resilient infrastructure is becoming more and more important. This means building things that can stand up to extreme weather and change the climate. From the beginning to the end of the building process, health

will be taken into account by using biophilic design principles, letting in natural light, and using materials that make the air inside better.

For green buildings to align with the Paris Agreement, stakeholders must adhere to the appropriate procedures and actively endorse these objectives and trends. This will enhance the health and resilience of habitats, benefiting both human beings and the planet.

Future goals and hopes for sustainable development in long range

The Paris Agreement is a global agreement that aims to promote the use of environmentally friendly construction methods in green buildings. Its goal is to achieve carbon neutrality by reducing the emissions of greenhouse gases and by promoting sustainability. This can be achieved by generating the same amount of renewable energy that is consumed, which will help in reducing the carbon footprint. The Agreement also highlights the importance of reducing waste and using the materials efficiently by following circular economy principles throughout the lifespan of a building.

Some of the long-term long-objectives include the integration of various energy sources like solar panels, wind turbines, etc., as efficient systems. Furthermore, this provides us with an alternative method of generating power, in addition to the utilization of fossil fuels. An alternative method for generating green energy involves utilizing geothermal heat pumps. Specialized intelligent devices, specifically created for application in residential and commercial structures, are aggressively promoted to decrease energy consumption, enhance air purity, and regulate ventilation systems. This contributes to the improvement of living and working situations that are more environmentally friendly.

Furthermore, there are also important aspirations regarding the conservation of biodiversity, the incorporation of inclusive design, and the preservation of cultural heritage within the green buildings sector for an extended period. It is crucial to prioritize the protection of nature within architectural spaces. Ensuring a healthy ecological balance between humans and their surroundings should always be of utmost importance from the planning stages to the finalization phase. Failing to do so would result in cities becoming uninhabitable, with a lack of trees, birds, and clean water, among other things. So, it's important for any design or construction process to not just meet but go beyond the minimum standards set by laws that protect biodiversity, no matter where they are in the world, especially if they are located nearby.

Another future goal of sustainable construction is the use of long-term Smart Building Technology (SBT). This concept utilizes modern data analytics and automation systems to maximize the consumption of energy in commercial buildings like hotels, malls, and supermarkets. It also enables real-time monitoring of waste production levels, providing managers with guidance on reducing wastage during normal operations, even in the absence of people. Ultimately, this leads to the creation of more pleasant environments for living that are both indoors and outdoors.

Furthermore, it is crucial to build easily reachable and cost-effective sources of sustainable energy, healthcare facilities, and educational institutions in every community. It is imperative to provide equal consideration to the conservation of various cultures while undergoing the development process. Failure to adequately plan in these areas will surely fail our systems. Hence, we urge all individuals to embrace a worldwide outlook when implementing measures at the local level. By taking action, we can increase our chances of achieving our goals (as discussed here) soon, instead of suffering imminent catastrophe if we don't make quick adjustments.

CONCLUSION

The successful implementation of green building methods requires the smooth collaboration of the contractors, engineers, architects, and clients in all stages. Green building is about safeguarding resources like water, land, energy, materials, etc., in the entire lifespan of the buildings. Its main goals are to protect the environment, reduce pollution, and provide people with a safe, pleasant, and efficient place by promoting balance in resources, reducing waste, and maintaining harmony with nature.

This study explains how waste materials can be used in the construction of green buildings to maintainable development by supporting the objectives of the Paris Agreement. It stressed the importance of using sustainable construction methods that reduce waste and promote recycling. It discussed the Paris Agreement, which states that these features are necessary and important to reduce greenhouse emissions globally.

In this study, various important points were brought up and discussed. One among them was the importance of minimizing waste in the design phase. Another one is the importance of research and adoption of sustainable methods for construction and waste management systems. It discussed that certain policies must be developed internationally like the

Paris Agreement. It also discussed the positive effects of using green building materials, which are made from recycling and reusing waste to achieve the goals that are laid down by the Paris Agreement.

The main objective of this study is to collect the existing knowledge about sustainable construction practices and their features. There are still a lot of areas that need to be looked into and researched. Apart from these, it suggests various ideas for research to be made in the future. A few of such possible future research is the investigation of circular economy models in green buildings, and another one is to analyze and assess the most efficient policies to encourage the reuse of waste materials. All these suggestions align with Sustainable Development goals made at the UN Climate Change Conference's COP 21.

These findings might help in providing valuable insights into the possibility of reusing materials and supporting sustainable building practices in the construction industry and it aligns with the goals that are set up in the Paris Agreement.

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REFERENCES

1. K. Andriuškevičius, D. Štreimikienė, *Energies*, **15**(13), 4557 (2022). https://doi.org/10.3390/en15134557
2. J. Teng, X. Mu, W. Wang, C. Xu, W. Liu, *Sustainable Cities and Society*, 44, 215–226 (2019). https://doi.org/10.1016/j.scs.2018.09.038
3. Y. Shen, M. Faure, *International Environmental Agreements: Politics, Law and Economics*, 21, 183–199 (2021). https://doi.org/10.1007/s10784-020-09495-3
4. Y. Wang, D. Chen, P. Tian, *Sustainability*, **14**(20), 13628 (2022). https://doi.org/10.3390/su142013628
5. C. Vindana, The importance of sustainability in the construction industry: Building a greener future (2024). https://www.linkedin.com/pulse/importance-sustainability-construction-industry-building-hewage-we1dc/
6. C. Jackson, How is green building sustainable?, *Construction21.org* (2022). https://www.construction21.org/articles/h/how-is-green-building-sustainable.html
7. R. Madiuk, *Coast Essential Construction* (2024). https://www.coastessential.com/waste-reduction-strategies-in-construction/
8. BRANZ, Designing for waste minimisation (n.d.). https://www.branz.co.nz/sustainable-building/reducing-building-waste/planning/designing-waste-minimisation/
9. D.C.I.S. Wa, Bullitt Center (n.d.). https://bullittcenter.org
10. NZEB, Indira Paryavaran Bhawan case study – NZEB (2023). https://nzeb.in/case-studies/nzebs-in-india/nzebs-in-india-case-studies-list/ipb-case-study/
11. H. Rama, Zero waste center | Sharing environmental knowledge & waste management training (n.d.). https://zerowastecenter.org
12. Habitat for Humanity, Habitat for Humanity ReStores (n.d.). https://www.habitat.org/restores
13. R.E. Amaral, J. Brito, M. Buckman, E. Drake, E. Ilatova, P.E. Rice, C. Sabbagh, S. Voronkin, Y.S. Abraham, *Sustainability*, **12**(13), 5337 (2020). https://doi.org/10.3390/su12135337
14. R. James, *Grantham Research Institute on Climate Change and the Environment and the Center for Climate Change Economics and Policy* (2020). https://www.lse.ac.uk/granthaminstitute/publication/aligning-finance-with-the-paris-agreement-an-overview-of-concepts-approaches-progress-and-necessary-action/
15. IDB, Paris alignment (n.d.). https://www.iadb.org/en/who-we-are/topics/climate-change/climate-change-finance/paris-alignment
16. N.C. Onat, M. Kucukvar, *Renewable and Sustainable Energy Reviews*, 124, 109783 (2020).https://doi.org/10.1016/j.rser.2020.109783
17. Y.H. Labaran, V.S. Mathur, S.U. Muhammad, A.A. Musa, *Cleaner Engineering and Technology*, 9, 100531 (2022). https://doi.org/10.1016/j.clet.2022.100531