



The Impact of the Green Building Materials on
Sustainable Development in Riyadh
(Proposal)

أثر استخدام مواد البناء الخضراء في التنمية المستدامة بالرياض
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Abstract

Green building materials (GBMs) are environmentally friendly compared to their traditional counterparts. Using of green building materials (GBMs) in achieving sustainable buildings is well recognized by the global construction industry. However, the major challenges of using the GBMs are information, awareness, incentive, and hard and soft logic regulations which are still limited in Riyadh either by local authorities, investors, consultants' offices, contractors, and suppliers.

Focused studies on how green building materials contribute to sustainable development are limited for Riyadh. This paper aims to provide systematic and comprehensive insights on current trends and future potentials of green building materials research by analyzing the existing literature reviews with their research features (i.e. research backgrounds, goals, and outputs), and using a mixed-methods approach, incorporating both quantitative and qualitative methods.

Keywords: Green Building Materials, Sustainable Development, Riyadh.

Introduction

Sustainable development has recently become central to international policy discussions [1]. The Kingdom of Saudi Arabia is committed to implementing sustainable development goals, placing them as a top priority in line with its specific principles. The Kingdom's vision 2030 as a whole is consistent with the sustainable development goals [2]. This scientific research aims to explore the impact of green building materials on sustainable development in Riyadh, Saudi Arabia and will investigate for other issues. Because the impact of building materials differs based on contamination and the material's function in each stage of its life cycle production from cradle to grave. Green materials with low or no impact on humans and the environment can decrease embodied energy, energy consumption (Papadopoulos and, CO₂ emission, indoor air pollution, and recyclability. This strategy is required to achieve sustainability in building materials. The mainstream theory for sustainability has become the idea of three pillars (3Ps): environmental, social, and economic sustainability. These 3Ps have been drawn in a variety of ways: pillars concentric circles, or interlocking circles. Therefore, applying sustainability to materials selection requires achieving all 3Ps of sustainability [3].

Through a comprehensive literature review and collecting the data by analysis of the case study, interviews, and samples the research provides insights into the potential of green building materials to mitigate environmental impacts and promote sustainable development in Riyadh. The findings of this study will contribute to the existing knowledge of green building practices and inform architects, and developers in their efforts to create more sustainable urban environments.

Research Problems

As mentioned, the focused studies on how green building materials contribute to sustainable development are limited for Riyadh, therefore the researcher has major challenges to collect, list, and discuss the previous studies combined with using a mixed-methods approach, incorporating both quantitative and qualitative, the questions are the following :

Main question

- 1- What is the green building materials impact on the sustainable development (economic, environmental, and social) in Riyadh?

Sub-questions

- 2- What are the benefits and challenges associated with the use of green building materials in the context of sustainable development in Riyadh?
- 3- What the existing policies and regulations related to green building materials and their effectiveness in promoting sustainable development in Riyadh?
- 4- What is the current level of awareness and adoption of green building materials in Riyadh?
- 5- What is the main criteria for green building materials selection?
- 6- What are the recommendations and strategies for enhancing the implementation of green building materials in Riyadh and achieving sustainable development goals?

The Importance and Objective of the Research

After Reviewing the previous studies, there is deeply lack of literature reviews (theoretical aspect) to show the impact of green building materials on sustainable development in the Arab world, especially in Riyadh city, therefore the researcher generated five objectives and he will also employ a mixed-methods approach, incorporating both quantitative and qualitative methods in order to enable the searcher to find real answers and conclusions.

A survey (practical aspect) will be conducted to collect data on the current use of green building materials in Riyadh, including their adoption rate, availability, and challenges faced by stakeholders. Additionally, interviews and a case study (for one LEED project under construction once get approval from real estate company) will be conducted with architects, engineers, and contractors, to explore their perspectives on green building materials and their role in sustainable development, the objectives are the following:

Objective # 1: Evaluate the economic, environmental, and social impacts of green building materials in Riyadh.

Objective # 2: Identify the benefits and challenges associated with the use of green building materials in the context of sustainable development and the main criteria for GBM's selection .

Objective # 3: Analyze the existing policies and regulations related to green building materials and their effectiveness in promoting sustainable development.

Objective # 4: Assess the current level of awareness and adoption of green building materials in Riyadh.

Objective # 5: Provide recommendations and strategies for enhancing the implementation of green building materials in Riyadh and achieving sustainable development goals.

Research Hypotheses

To achieve the objectives of the research, the researcher will be looking for facts and evidence for the following hypotheses:

Hypothesis # 1: There is a significant impact of using green building materials on the economic, environmental, and social in Riyadh.

Hypothesis # 2: There are the benefits and challenges associated with the use of green building materials in the context of sustainable development.

Hypothesis # 3: There is a significant relation between the existing policies and regulations to green building materials and their effectiveness in promoting sustainable development.

Hypothesis # 4: There is a significant impact of the current level of awareness and adoption on using of green building materials in Riyadh.

Literature Review

The study of [4] linked to hyp. # 1, aim to achieve reducing carbon dioxide emissions is through building insulation. Thermal insulation plays a significant role in energy conservation and sustainable development in civil engineering. Older construction materials such as roof and wall units have high thermal transmittance, but this can be significantly reduced by adding insulation material. In this study, we aimed to evaluate the performance of different insulation materials on conventional buildings. We found that while U-values were low in non-insulated conventional buildings with subsequent high temperatures, insulated roofs and walls had high U-values. We measured the thermal conductivity values of different insulating materials and found that polyurethane foam had a K-value of 0.01 with a density of 35–40 kg/m³. We applied various thicknesses of insulation and non-insulation materials to achieve the recommended U-factor and R-value according to the ECBC criteria for conventional buildings. Keeping in view the above objective following conclusions were found with the application of polyurethane.

The study of [5] linked to hyp. # 1 aims to achieve production of about 50% of renewable energy from the total energy that Saudi Arabia needs based on solar plants. The construction projects are still not clearly considered in the policies and regulations. The construction projects contribute only 1.6% based on the official renewable energy 2020 statistic. Therefore, a holistic study as an assessment and evaluation approach for the selected case study inside a university campus as a public construction project in Saudi Arabia was conducted. The aim of this study was to provide a pioneering example for achieving a retrofitting process and a near zero energy campus to support the Saudi Arabia 2030 Vision. The holistic study explored the quantity of contributions in improving the energy performance and updating the bidding documents to achieve advanced ranking in the construction sustainability standards. The selected case study from the campus projects was the shell envelope of the talent and research center project. This project was under construction and was registered in the LEED to obtain the golden certificate in sustainability with a total of 68 points (37 points in the design phase and potential 31 points in the construction phase). By applying the holistic approach and analysis for the entire contract documents for the shell envelope, significant goals were achieved. PVsyst V7.1.0 software was used for solar analysis to redesign and implement the steel dome covered with 30% double structured glass and 70% composite aluminum on a surface of 9500 m² to give 4750 active BIPV solar panel panels on the entire surface of the case study building. It involved two comparative analysis stages. The

significant goals included the upgrading of the building energy performance by generating electricity with approx. 925 kWp and about 1,320,000 kWh/year, which covers 68% of the energy building needs, achieving an annual saving of about 436 thousand riyals annually. The significant goals also include the building's upgrading in the sustainability rating system from gold certificate to platinum certificate based on energy performance by obtaining another 20 points in credit EAc1: optimize energy performance and credit EAc2: on-site renewable energy. Other significant results include reducing 7 tons of CO₂ annually and saving oil burning consumption to about 7 Barrels/m². In addition, the cost of the proposed solar BIPV modules is less than the cost of the design bidding item, and transparency increased. Since all building roofs were designed as outdoor areas, this enhances the positive visual interaction between the outdoor and the indoor and the psychological comfort of the building's occupants.

The study of [6] linked to hyp. # 1 & 3, about the challenges and regulations for using green building. The Saudi government's circular carbon initiative provides other solutions to the barriers to green building adoption, as these initiatives directly acting upon climate change ensure the reach of clean and cheap energy. All businesses are encouraged to take not only circular carbon initiatives to support the government's CCE program, but also offer different incentives for adopting environmentally friendly policies. Therefore, CCI may play an important role in eliminating key barriers to the adoption of green buildings. For this purpose, the government of Saudi Arabia has taken many initiatives in alliance with four key factors: reduction, recycling, reuse, and removal. Under the heading of reduction, the KSA launched an energy efficiency and conservation program in 2012 that covers key energy efficiency activities practiced across different sectors, including industry, buildings, and transportation, satisfying 90% of the energy demand of the country. Approximately 35 initiatives focus on capacity building, governance, public awareness, energy efficiency standards, benchmarks, and specifications (Shehri et al, 2022). Second, fuel is switched from oil to natural gas reserves to reduce the country's oil consumption for power generation by 2030. Third, there is an increased reliance on the use of nuclear and renewable energy to overcome environmental concerns. Although the Saudi government is looking for recycling solutions and possibilities for biofuel production, there is still no recycling potential in the country (IEA, 2020). Next, to build reuse capacity, the Saudi government is largely funded by research and development but still falls behind because the largest industrial city of Jubail is only partially eligible to reuse CO₂, following the CCE guidelines (Shehri et al, 2022). Finally, the country is still struggling to eliminate the negative effects of carbon emissions to overcome environmental problems. Therefore, based on the initiatives taken by the Kingdom of Saudi Arabia, the study concludes by integrating green initiatives with CCI initiatives to overcome the potential barriers to the adoption of green concepts in the country, particularly green buildings. This could be the best way to encourage businesses to adopt green solutions to support the government's CCE program.

The study of [7] linked to hyp. # 2 & 4, taking about the SDGs, the interrelated nature of the SDGs highlights the interlinking between the economic (e.g., industrialization), social (e.g., health), and environmental (e.g., climate change) sectors. SDG 4 (education and training) is considered a foundational SDG because it affects the accomplishment of most of the other SDGs. Further, it maximizes synergy and minimizes tradeoffs among SDGs. Therefore, the current study suggests that developing nations such as Saudi Arabia should continuously enhance their human capital through targeted education and training programs to achieve the SDGs. Saudi Arabia's Vision 2030 provides a broad framework for developing a knowledge-based economy; however, education and training programs should be tailored to advance the SDGs that have the greatest impact on the economic growth. Therefore, education and training policies should promote gender equality and the empowerment of women, environment protection, decent employment opportunities, and human capital development. The government should encourage educational institutions to combine traditional and digital

systems to increase access to education and training. Additionally, the Saudi government should ensure the equitable distribution of socioeconomic opportunities and educate the populace on how to address socioeconomic issues such as food waste. The government of Saudi Arabia should promote laws and regulations that encourage an equitable, healthy, and safe work environment in the current technological workspace. The Saudi government should provide robust institutional support to the private sector to provide decent and safe employment opportunities, expedite the development of essential infrastructure, and the adoption of emerging technologies. Consequently, Saudi Arabian policymakers should continue to initiate and implement policies that promote education and training, as well as other lifelong learning opportunities, sustainable employment generation, human capital development, economic growth, and technology-enabled socioeconomic empowerment. In addition, the Saudi government should continue to promote prudent education and training policies to expedite economic recovery throughout and after the COVID-19 pandemic. This is because education and training (SDG 4) as a foundational SDG will positively influence Saudi Arabia's economic, socioeconomic, health, and environmental sectors (throughout and after the COVID-19 pandemic).

The study of [3], The development of a green material index was the prime objective of the study, and a model has been successfully applied in ranking building materials to provide the best solution for a green and sustainable project. A total of 23 criteria were identified thorough literature review and discussion with selected experts in the use of green materials for building projects. By considering a hybrid MCDM methodology, the study tried to resolve multiple incompatible and conflicting GBM criteria to align with 3Ps sustainability. Obtained results indicate that the relationship between GBMs and sustainability criteria are different based on the separate 3Ps of sustainability. The GBM criteria prioritizing and aligning with the sustainability criteria revealed that affordability is one of the important GBM criteria in the selection procedure that assembles materials with life-cycle cost specifications comparable to conventional materials. Resource efficiency was highlighted as the second most important criteria. The results suggest that natural, renewable, and recycled content are resource-efficient criteria for GBM selection. The embodied energy was weighted as the third specification for the energy efficiency term in GBM selection. Additionally, non-toxic materials with low-VOC assemblies highlight the indoor air quality characteristic in the GBM selection procedure. The final criteria ranking considering the social aspect highlights the IAQ categories for GBM selection as a health issue, particularly using natural and renewable resources and energy efficient materials during the life product of materials. Consideration of these criteria will ensure a green material selection and consequently a sustainable development in building design and construction. The present study is only a tentative beginning in this direction. This research has opened up opportunities for further research in selecting the best green building materials. The findings in this research can be further extended and modified to accomplish the ultimate goal of promoting and improving green practices in construction. The evaluation and results can provide a valuable reference for building professionals who seek to enhance sustainable construction through green materials.

Research Methodology

There are two major methods used to identify, collect, assess, analysis, evaluate, and observe the impact of the green building materials on sustainable development in Riyadh :

Qualitative (previous studies, interviews, case studies)

Quantitative (Survey)

Research Limits

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