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Construction material management solutions for social housing projects toward sustainable development in Vietnam

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ABSTRACT

Toward sustainable development goals, the construction industry has faced several challenges. Many researchers and practitioners have pointed out that material, accounting for 50 to 70% of construction costs, should be prioritized for studying. To meet the housing demands for low-income people, the Vietnamese government has launched a strategy to develop 1 million social housing units from 2021 to 2030. Many social housing projects have been actively implemented across the country recently to achieve this goal. However, effectively accessing and using construction materials sustainably in these projects still faces many challenges. The sustainability of construction materials is not only measured by their physical durability and technical performance but also considers factors such as environmental impact, human health safety, and recyclability. Particularly, given the large scale and profound impact of social housing projects, smart and sustainable selection and utilization of construction materials are crucial. This article proposes solutions and management strategies for developing construction materials in social housing projects in Vietnam, aiming at the goal of sustainable development and advancement of the construction industry.

1. Introduction

Homeownership is considered a fundamental need of citizens in every country, and governments worldwide always prioritize researching various solutions to address housing issues. In major cities like Hanoi and Ho Chi Minh City in Vietnam, housing affordability, whether renting or buying, often faces numerous challenges, necessitating government intervention on many fronts. Therefore, in April 2023, the Government of Vietnam approved the project: "Project for constructing at least 1 million social housing units for low-income people, industrial zone workers for 2021-2030 period" [1]. The project aims to develop social housing and workers' housing with prices suitable for the affordability of urban low- and middle-income households, as well as industrial zone workers and labourers.

However, the construction and management of Vietnamese social housing are facing many challenges, including issues related to sustainable development [2]. In the construction environment, materials play a crucial role, from building infrastructure to constructing residential buildings. The choice of suitable materials not only affects the performance and quality of the project but also its environmental sustainability. Meanwhile, traditional materials often have negative impacts on the environment, including energy and natural resource consumption, air and water pollution, and the generation of hazardous waste.

In this context, the trend of using sustainable materials is gradually becoming popular in the construction industry. However, applying sustainable materials in social housing development is not an easy process [3]. It requires close collaboration among stakeholders, from material producers to governments and non-governmental organizations, as well as positive awareness and action from the community and management authorities. Additionally, supportive policies and legal regulations are needed to promote the use of sustainable materials in social housing construction, along with incentives and technical measures to foster the development and utilization of these materials.

Many researchers and practitioners have sought after sustainable social housing development [2] and sustainable construction material implementation issues [4]. Nevertheless, there have been no studies that have delved into the use of sustainable construction materials in social housing projects in Vietnam. By the document analysis and synthesis methods, this article proposes solutions and management strategies for developing construction materials in social housing projects in Vietnam, aiming at the goal of sustainable development and advancement of the construction industry.

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2. Literature review

2.1. Social Housing

The concept of Social Housing began to emerge in countries like the UK, the USA, and Canada in the 1970s. Initially, most Social Housing was owned by the state, but later there were also housing associations and charitable organizations participating partly to sustain the lives of those living in social housing. Depending on specific circumstances, Social Housing applicants may be completely exempt from fees or offered low-cost rentals. However, there is still no unified definition of Social Housing, leading to different perspectives on Social Housing in each country.

In the 2010 decision on the Dutch social housing system by the European Commission, social housing was defined as the provision of housing at below market price to a target group of disadvantaged people or socially less advantaged groups, as well as to certain categories of key workers. The target group as well as the exact modalities of the service are defined by the public authorities. Social housing providers can also provide other related services to the target groups. [2,5].

In Vietnam, Article 3 of the Housing Law of 2014 defines Social Housing as "housing supported by the State for subjects entitled to housing support policies according to the provisions of this Law" [6]. Compared to the regulations in the Housing Law of 2005, the definition of Social Housing has changed. In 2005, Social Housing could be provided by the state or organizations and individuals belonging to economic components investing in construction, but now Social Housing is supported by the state [7]. From the above definition, it can be seen that in Vietnam, Social Housing is housing supported by the government (through land and financial assistance) to provide affordable products for low-income employees or people to buy, rent, or rent-to-own, separate from commercial housing (operating entirely under market mechanisms).

2.2. Sustainable development

Sustainable development originates from various sources but can be considered a combination of ideas and social movements from the 20th century. The concept of sustainable development was initially introduced in the "Our Common Future" report by the Brundtland Commission in 1987 [8]. This report, known as the "Brundtland Report," defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This is considered the most basic and widely accepted definition of sustainable development and has since generated global interest in the issue. At the Earth Summit on Environment and Development held in Rio de Janeiro (Brazil) in 1992 and supplemented, completed at the World Summit on Sustainable Development held in Johannesburg (South Africa) in 2002, the concept of sustainable development was affirmed as "a process of development that integrates the closely, reasonably and harmoniously between three aspects of development including economic development (economic growth), social development (implementing progress, social justice; eradicating poverty and addressing employment) and environmental protection (handling, remedying pollution, restoring and improving environmental quality; fire prevention and forest clearance; rational exploitation and economical use of natural resources)" [9].

2.3. Sustainable materials

The concept of sustainable materials stems from the need to develop a construction industry responsible for the environment and society, understood as materials produced or used beneficially for the environment, minimizing negative impacts on natural resources and humans. The application of sustainable materials in the development of social housing not only improves the quality of life for the community but also contributes to society's sustainable development goals.

3. Developing construction materials for social housing worldwide

The construction industry has a significant impact on the environment, accounting for a large proportion of CO_2 emissions, energy consumption, construction waste, and water usage. 40% of global CO_2 emissions are generated by the construction industry, while its energy consumption accounts for 33%. Construction waste constitutes 40% of the total waste, and water usage in the construction and operation of buildings also contributes 20% [10].

The strong environmental impact of the construction industry is one of the main causes of climate change. 98% of indirect CO_2 emissions come from the use of energy in the operation of construction projects. To mitigate this negative impact, green buildings and the use of green materials have been proposed as solutions. Green buildings and green materials play a crucial role in reducing the environmental impact of the construction industry. They help reduce energy consumption by up to 24% to 50% [11], decrease CO_2 emissions from 33% to 39% [12], reduce water usage by up to 40%, and decrease solid waste by up to 70% [13].

3.1. General Solutions for Developing Construction Materials Worldwide

Since 2015, the United Nations has set forth 17 Sustainable Development Goals (SDGs) for the period 2015-2030 [14]. These goals are interconnected to address major development challenges facing the world. Among the 17 SDGs set by the United Nations, the construction industry contributes indirectly and directly to 9 specific goals (Figure 1). However, in Vietnam, the focus is on 3 specific goals: Goal 7: “Affordable and Clean Energy”; Goal 11: “Sustainable Communities and Cities”; and Goal 13: “Climate Action”.

Figure 1. Construction sector objectives contributing to enhanced awareness

Source: Author's compilation from [14]

The current international context indicates that the global economy is projected to grow at an average rate of 3.2% per year during the period 2025-2035 [15], with trade integration, urbanization, and technological advancement being the main driving forces. The trend of development in construction materials worldwide is closely linked to the application of advanced, modern technologies, resource efficiency, utilization of industrial waste, reduction of energy consumption and low-carbon emissions, and adaptation to climate change. There is a growing variety of construction materials products, including energy-saving construction materials, and green construction materials with high quality and added value, surpassing traditional construction materials. The development of construction materials worldwide is also strongly influenced by trends in technological innovation in the Fourth Industrial Revolution, with advances in digital technology, modern machinery, artificial intelligence, and big data.

Vietnam is increasingly integrating into the international community, and therefore, the development of construction materials in Vietnam is inevitably affected by global trends in construction materials development and scientific and technological advancements. The development of construction materials in Hanoi follows the general trends of both the country and the world. In recent years, there has been a shift in the criteria for the development of construction materials. Instead of merely contributing to economic development and providing employment for workers, the trend of construction materials development is increasingly aligned with the perspective of sustainable development, harmonizing all three main factors: political, economic, social, and environmental. Research and development of construction materials that do not use or only partially use raw materials directly extracted from natural resources, while increasing the content of recycled materials and fuels from industrial waste, household waste, and demolition waste, are being vigorously pursued.

3.1.1. Trends in Green Construction Materials Development

Green construction materials can be defined as materials used through environmentally friendly methods. Evaluation criteria may include total energy consumption in the extraction, transportation, construction, use, and demolition processes, as well as total waste and pollutant emissions during these processes.

The report of Maximize Market Research PVT.LTD (MMR) on the Green Building Materials Market was valued at approximately USD 252.63 billion in 2022 and is estimated to reach USD 467.8 billion by 2029, with an annual growth rate of 9.2% (Figure 2). The Asia-Pacific region holds the fastest-growing market position in terms of Compound Annual Growth Rate (CAGR) and is expected to continue this trend throughout the forecast period. The European region has an annual growth rate of about 10% due to strong demand in the housing market driven by increasing incomes, low-interest rates, and high levels of migration [16].

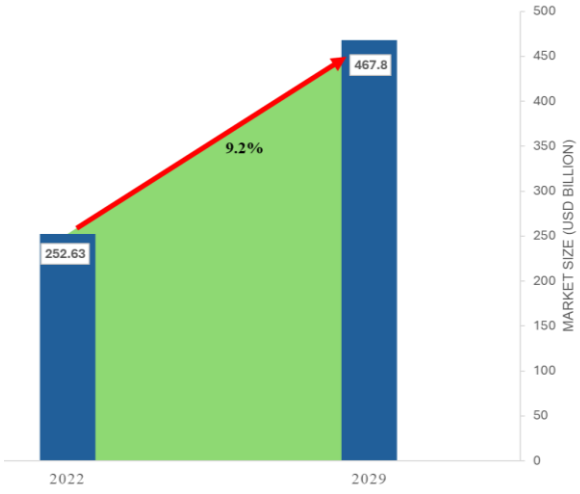

Figure 2. Forecast of green construction materials market growth (Unit: USD billion)

Source: Author's compilation from [16]

The MMR research also indicates that the biggest ratio of green material types is exterior products. This segment was expected to increase to 8.2% during the forecast period. Hold the second market share ratio, the structure product segment is estimated to grow at 11.8%. This higher number is due to its ability to lower carbon emissions. Consumer awareness about the benefits of sustainable development (especially environmental benefits) leads to the interior material market demand increasing. The application of green construction material in insulation is also expected to see an 11.5%

growth rate in 2029, while roofing and framing implementation is expected to showcase a considerable increase in the market (Figure 3).

Figure 3. Green Building Materials application segment overview (Unit: %)

Source: [16]

3.1.1.1. Utilization of Materials Recycled from Waste

The amount of waste generated usually follows the law of mass conservation. The volume of waste, including both solid and liquid waste, dispersed annually worldwide is estimated to be in the billions of tons. Most of it still has utility value or the potential for reuse, especially in construction. Under the pressure of the Rio de Janeiro Agreement and the Kyoto Protocol [17] on environmental protection, most developed countries have paid attention to this issue and have achieved certain achievements in reducing, reusing, recycling, and recovering waste.

The energy consumption required to produce some commonly used construction materials can be effectively reused in the construction industry. These include waste generated from demolishing construction sites, metal waste, waste from thermal power plants, waste from steel mills, glass waste, rice husk waste, and various types of oil waste. Utilizing these materials to the fullest extent would significantly reduce the amount of natural resources extracted. It would also substantially decrease the energy consumed in the extraction and processing of natural materials. This means saving valuable resources and minimizing environmental pollution. In other words, it is a solution to achieving the goal of using sustainable materials.

3.1.1.2. High-Durability Material Usage

A sustainable material must simultaneously meet criteria for mechanical properties such as strength, elasticity modulus, deformation resistance, abrasion resistance, and physical properties such as volume, heat, sound, water, and especially resistance to environmental factors such as corrosion, carbonation, and ageing.

A construction project using high-durability materials will prolong the service life of the project. The initial investment cost may be higher than traditional materials. However, in return, the operating costs are lower (reflected through maintenance, repairs, etc.). Additionally, the extended material usage lifecycle is an important factor in reducing energy consumption for construction and extraction, as well as reducing waste generation. These benefits not only enhance investment efficiency but also contribute to the goal of environmental sustainability.

3.1.2. Promotion of Digital Transformation and application of Industry 4.0 Technologies in the construction materials sector

To enhance the competitiveness of construction materials products, construction materials manufacturing enterprises need to apply the pillars of the fourth industrial revolution, with digital transformation being a crucial factor.

To carry out digital transformation, enterprises need to convert all information, and data related to the enterprise, from mining, material supply, spare parts, production, logistics, sales, management, operations, planning, organization, and personnel... into digital signals that computers can read, store, manage, process, and transfer from one place to another through internet connectivity.

3.2. Experiences of other countries in managing construction materials for social housing towards sustainable development

3.2.1. Singapore's experience

Singapore is renowned for its successful development of public housing, known as Housing Development Board (HDB) flats. Currently, Singapore has over 1 million HDB flats, accommodating 80% of the population. The country boasts one of the highest homeownership rates globally, with a key achievement being the satisfaction of residents with their housing, neighbourhoods, and real estate, while still ensuring affordability for all. In 1960, the Housing Development Board (HDB) was established with special autonomy in financial assurance and exemption from building laws, enabling operations without the approval of other agencies [18].

HDB is a pioneer and leader in precast technology, with this technology applied to about 70% of each project. It meets the environmental and weather conditions of Singapore and has helped HDB achieve high construction quality and productivity in developing its high-rise buildings. Precast components include beams, columns, facades, partition walls, parapet.

3.2.2. United Kingdom's experience

Beddington Zero Energy Development (BedZED) in London is the world's first socially integrated housing complex, consisting of homes for sale, homes for nearby workers, and social housing for rent, with the goal of zero-carbon energy consumption [19]. It is a pioneering social housing project using sustainable materials and technologies. The project utilized a range of green materials and solutions to minimize environmental impact and create a sustainable development model:

(1) Recycled and FSC-certified wood: BedZED used recycled wood and FSC-certified wood (Forest Stewardship Council) to construct

buildings and structures in the project. Using recycled wood and wood from sustainably managed forests helps minimize environmental impact and protect forest resources;

(2) Thermal and sound insulation materials: Buildings at BedZED were constructed with high-quality thermal and sound insulation layers to reduce energy consumption and noise from the outside;

(3) Solar energy: The project integrated solar energy systems to generate electricity for common utilities and hot water systems in buildings, reducing the amount of electricity consumed from the main grid;

(4) Recycled building materials: BedZED also uses recycled building materials such as recycled concrete and recycled glass to reduce waste and environmental impact.

3.2.3. Experiences from United States

Via Verde is a social housing project in the Bronx, New York, designed to ensure sustainability through the use of green materials and advanced technologies. Recycled building materials: During construction, Via Verde used recycled building materials such as recycled wood and recycled soundproofing materials to reduce waste and environmental impact. Via Verde also employed other green materials such as non-toxic paint, FSC-certified wood to protect forest resources, and natural thermal and sound insulation materials such as straw and sugarcane bagasse [20].

4. Proposal development solution of construction materials for social housing projects toward sustainable development in Vietnam

Nowadays, the development of construction materials has seen a shift in criteria. Instead of solely contributing to economic development and creating employment for workers, the trend in the development of construction materials is increasingly aligning with the perspective of sustainable development, harmonizing all three main factors: political, economic, social, and environmental. Research on the development of construction materials involves reducing or eliminating the use of raw materials directly extracted from natural resources. Additionally, there is an emphasis on increasing the proportion of recycled materials and fuels derived from industrial waste, household waste, and demolition waste from construction sites, which is being actively implemented.

At the COP26 climate summit held in Glasgow, Scotland, United Kingdom, Prime Minister Pham Minh Chinh affirmed, "Despite being a developing country, having only begun industrialization over the past three decades, Vietnam will build and implement stronger measures to reduce greenhouse gas emissions using its resources, along with cooperation and support from the international community, both financially and in technology transfer, including implementing mechanisms under the Paris Agreement, to achieve 'Net Zero' emissions by 2050" [21]. To realize this commitment, Vietnam has issued numerous policies such as the National Strategy on Green Growth for the period 2021 - 2030, with a vision to 2050; the National Strategy on Climate Change for the period up to 2050; and the implementation of the National Program on Energy Efficiency and Conservation for the period 2019 - 2030. Particularly, under Decree No. 06/2022/ND-CP regulating the reduction of greenhouse gas emissions and the protection of the ozone layer [22], the Government of Vietnam mandates that by 2030, the construction industry must reduce 74.3 million tons of CO_2 equivalent (accounting for 13% of the total emission reduction) in industrial processes and energy use in the production of construction materials and buildings.

4.1. General development solution of construction materials

4.1.1. Perspective

On August 18, 2020, the Prime Minister issued Decision No. 1266/QD-TTg approving the Vietnam Construction Materials Development Strategy for the period 2021 - 2030, with a vision to 2050 [23], outlining specific perspectives as follows:

(1) Develop the construction materials industry efficiently and sustainably to meet basic domestic needs, gradually increase exports, and contribute to promoting economic and social growth;

(2) Quickly access and apply scientific, technological, and management achievements, especially those of the fourth industrial revolution;

(3) Efficiently use resources, thoroughly save energy, and raw materials;

(4) Minimize environmental impact during the extraction, processing of mineral resources for construction materials, and production of construction materials;

(5) Promote and encourage economic components to invest in and develop the construction materials industry;

(6) Allocate the network of construction materials production facilities nationwide to the natural and social conditions of each region.

4.1.2. General Objectives

Decision No. 1266/QD-TTg, besides presenting the perspective for the development of the construction materials manufacturing industry, also outlines the general objectives of the industry, specifically:

(1) Develop the construction materials manufacturing industry to an advanced and modern level; products meet international standards, use energy efficiently, have high competitiveness in the international market, and meet the needs of the domestic market;

(2) Eliminate outdated construction materials manufacturing technologies that consume many resources and cause environmental pollution;

(3) Export products with high added value and strong competitiveness in the international market. Limit the export of products that use many non-renewable mineral resources.

4.2. Enhancing management solutions for the development of construction materials for social housing in Vietnam towards sustainable development

4.2.1. Issuing standards, regulations, guidelines, and economic-technical norms related to the use of construction materials for social housing

The issuance of standards, regulations, guidelines, and economic-technical norms regarding construction materials is extremely important in ensuring the quality and safety of social housing projects. This is not only a crucial step but also the foundation for sustainable development and improving the quality of life for the community.

Furthermore, guidelines and economic-technical norms play a vital role in optimizing the use of materials. By accurately determining the required amount of materials for each project, we can avoid waste and save precious resources. Additionally, usage guidelines help workers understand how to use materials efficiently and safely, thereby minimizing health and safety risks.

These standards, regulations, and guidelines also play a significant role in creating a healthy competitive environment for construction material production and supply businesses. By applying quality and safety standards, the government can create a level playing field for businesses while encouraging innovation and improvement in this field. Currently, the legal framework for social housing in Vietnam, especially regarding construction materials, still has many shortcomings. Existing standards, regulations, and green building certifications do not fully align with the criteria and models of social housing.

4.2.2. Studying and applying the development of various types of sustainable construction materials

Vietnam is one of the countries with great potential to develop and apply new and efficient types of construction materials. Among these, recycled materials, such as bricks made from plastic waste, recycled wood, or recycled concrete, are attractive options. Using these materials not only helps reduce waste but also creates highly sustainable housing.

Furthermore, to minimize energy consumption and environmental pollution, the market has introduced "green" materials that reduce CO_2 emissions, such as:

(1) Gypsum-based interior plaster, as a substitute for cement-based plaster, can reduce CO_2 emissions by up to 75%;

(2) Glass production using hydro-based raw materials. With this new technology, CO_2 emissions directly into the environment are reduced by 70% compared to conventional glass production

(3) Aerated lightweight concrete: Aerated lightweight concrete is designed as a one-step mixing process that does NOT require using the foam generator at all, which makes the process faster/cheaper/more ecological/more stable. It uses a low quantity of cement and natural sand that reduces carbon footprint. The main difference from conventional concrete is that the mixing is performed at a high-speed mixer of special design.

4.2.3. Education and raising awareness in the community about the use of sustainable construction materials

Education and raising awareness in the community about the use of sustainable construction materials are essential. Firstly, the government needs programs and workshops to raise awareness among construction companies and the public about the importance of choosing materials that benefit the environment and human health. Additionally, policies should be established to encourage and support businesses to facilitate access to and use of sustainable construction materials more easily.

One of the most important measures to promote the use of sustainable construction materials is through the establishment of transparent and successful social housing models. Social housing projects should be designed and constructed based on sustainable principles, from material selection to energy saving and resource reuse.

4.2.4. Mechanisms for encouraging businesses to use sustainable materials for social housing projects

In the realm of social housing in Vietnam, the implementation of policies that encourage the use of sustainable building materials plays a crucial role in establishing a sustainable living environment conducive to the well-being of the people.

One significant policy mechanism involves applying favourable tax policies for the utilization of environmentally friendly and energy-efficient building materials. The government can implement low tax rates or tax exemptions for enterprises engaged in the production and utilization of construction materials certified for their sustainability and energy efficiency. This approach not only incentivizes businesses to adopt advanced technologies but also promotes the development of an eco-friendly construction materials industry.

Moreover, establishing financial support policies is another critical factor in encouraging businesses to adopt new and efficient building materials. The government can provide preferential loan packages or investment capital support for enterprises willing to invest in researching and developing new construction materials, especially recycled or reused materials.

In addition to the aforementioned policies, creating a healthy and transparent business environment also plays a significant role in encouraging businesses to use sustainable building materials. The government needs to promote fairness and transparency in commercial

transactions, ensuring that enterprises using sustainable and certified building materials will receive incentives and priority in public projects and social housing.

5. Conclusion

In the 4.0 era, as Earth's resources are gradually depleting and the impact of climate change is becoming increasingly severe, the use of sustainable building materials is an urgent issue not only for each household but also for the entire community. In Vietnam, the demand for social housing is increasing rapidly, especially in urban areas undergoing development. However, the use of unsustainable building materials is causing many serious problems, from resource depletion to environmental pollution. Traditional building materials often require significant consumption of raw materials and energy during production processes. It not only increases costs but also negatively impacts the environment and human health. Air and water pollution, as well as natural resource extraction, have led to many serious issues.

However, using green materials in social housing construction brings many benefits to the environment. The benefits of using green materials for social housing will help minimize the human impact on the natural environment by using recycled resources and reducing waste generation. These green materials also encourage creativity, finding new solutions that are useful and environmentally friendly, promoting a safer way of living and working.

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