

Impact of Green Cement on Sustainable Development of Lagos Megacity

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Abstract

Cement production is a significant contributor to greenhouse gas emissions globally, and Lagos Mega City is not exempted from the impact of this industry on its environment. Green cement, a more sustainable alternative to traditional cement, has been proposed as a solution to reduce the carbon footprint of cement production. This study assessed green cement for promoting sustainable development in Lagos Mega City. A quantitative research method was used in the form of a survey questionnaire administered to Building Industry professionals (BIPs) in Lagos Mega City to investigate the level of awareness of green cement, its potential and barriers to sustainable development. 121 responses gotten was coded and analyzed using statistical techniques for Social Sciences (SPSS). The study identified the potential economic, social, and environmental benefits of green cement for Lagos Mega City alongside challenges and barriers to its adoption. The finding revealed that the level of awareness of what green cement is seems to be foreign to professionals in the built environment with over 76% acknowledging little or no knowledge of the term. However, despite the low awareness level, and difference in opinion on impact, a close look suggested acceptance of his positive environmental benefits to Lagos Mega City's sustainable development. This result provides evidence-based recommendations for policymakers, entrepreneurs, and industry experts on how green cement can be integrated into the construction industry of Lagos Mega City to achieve sustainable development.

Keywords: Construction Industry, Green Cement, Greenhouse gas emission, Sustainable Development

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Introduction

Three materials, cement, steel, and aluminium, account for the same quantity of pollution as all of the world's automobiles, a reality that is becoming more widely acknowledged. In the article, "*Cement Is the New Coal*", it was emphasized that despite making up only 12% of concrete, cement (Portland Cement) accounts for 77% of CO₂ emissions and 8% of the world's greenhouse gas emissions (GHG). Cement is popular because it is the primary component of concrete as infrastructure and construction projects use concrete around the globe (Hart, 2022). Parikh (2011) expressed that the cement industry uses a lot of energy and produces many

emissions. This currently hurts the environment (Chiara, 2011). Governments and businesses who recognize that the current pace of release of this greenhouse gas into the atmosphere is a severe threat to future life and prosperity on the planet support efforts to regulate global CO₂ emissions. However, as a result of population expansion, higher industrialization, and increased economic activity in developing countries, the rate of increase in emissions almost continues unabatedly (Imbabi, Carrigan, & Mckenna, 2013). By partially substituting the clinker component with non-hazardous waste, sustainable cement can be created. Although their widespread use is still somewhat restricted, Portland-composite cement made from fly ash, silica fume, or blast furnace is considered sustainable cement's first possibility of eco-friendly cement (Chiara, 2011). With these understandings, the study aims to assess the potential of green cement for promoting sustainable development in Lagos Mega City with specific objectives to evaluate the level of awareness, analyzing of economic, social, and environmental implications and, challenges of green cement in Lagos Megacity to sustainable development.

Literature review

Lagos Megacity

Lagos is a city in Nigeria and is often referred to as a "megacity" due to its enormous size, population, and economic significance (Dekolo & Oduwaye, 2011). According to the United Nations, a megacity is a metropolitan area having a population of more than 10 million people (UNDESA, 2013). Nineteen (19) megacities have been identified in the world with the figure expected to reach 27 by 2020 with Lagos as one (UNFPA, 2005), (Mathematics, 2016). With a built-up area that is constantly growing, the Lagos Mega-City region is estimated to be the size of Lagos at 153,540 hectares including a portion of the nearby Ogun State (Brazel, 2002). Ado Odo/Ota, Ifo, Obafemi-Owode, and Sagamu are the four local government areas (LGAs) in Ogun, making up the majority of Lagos State's local government areas (LGAs). The Lagos megacity has traditionally been renowned for its expanding urban population expansion (Lawanson et al., 2022).

Lagos is the economic hub of Nigeria and one of the major financial centres in Africa with a high level of construction going on daily to meet the uncontrollable high demand. It contributes significantly to Nigeria's GDP and attracts both domestic and international investment (Lawanson, Alade, Unuigboje, & Faniran, 2022). The city is home to a wide range of industries, including banking and finance, telecommunications, manufacturing, entertainment, and

services. The high level and impact of the construction industry within the city calls for sustainable development. Informed by the level of growth, the Lagos State Government came up with “Lagos State Development Plan (LSDP) 2052. The planned project is “Lagos to be Africa’s model mega city and global, economic and financial hub that is safe, secure, functional and productive”(Economy & Infrastructure, 2020).

Figure 1: 400+LSDP INITIATIVES OVER THE NEXT 30YEARS

Source: Economy & Infrastructure (2020)

Sustainable Development of Lagos Megacity

Brundtland Commission defined “sustainable development as development which meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). Also, it can be defined as “the process by which we move towards or consider sustainability” (Berardi, n.d.). Sustainable development in Lagos, one of the world’s largest cities, is a crucial concern due to its rapid urbanization, population growth, and environmental challenges (Emordi & Osiki, 2008) and this cannot be achieved without the use of cement due to its importance in construction. According to UNDESA (2013), integration and coordination are necessary for the sustainable development of metropolitan areas, particularly when it comes to housing, infrastructure development, biodiversity preservation, and land use issues among others. Fabiana Meijon Fadul, (2019) expressed while quoting United Nations Report, n.d. (2001) stressed that by refocusing research and development efforts as well as implementing institutional changes, sustainable development seeks to balance population expansion with the use and exploitation of natural resources.

Portland cement, Green cement and Greenhouse gas emissions (GHG)

The largest manufactured good on Earth in terms of mass is cement (UN Environment Programme, 2016) and cement consumption dominates the building construction business in Nigeria. In Nigeria, cement is used in the construction of more than 95% of private and public buildings. In urban areas, nearly all new construction is made of cement (Egenti et al., 2014). Green cement, also known as eco-friendly cement, or sustainable cement, has the potential to play a significant role in promoting sustainability by reducing the environmental impact of cement production and construction. It is a term used to describe cementitious materials that have a reduced carbon footprint compared to conventional Portland cement. Industrial waste products like fly ash, slag, and silica fume are used as source materials in this cement. Fly ash is a byproduct of the coal combustion process in power plants and can therefore be considered a waste material. Fly ash and blast-furnace slag reduce dust emissions by 9,800 tonnes annually and CO₂ emissions by 33.6 Mt annually, making them among the most practical ways to lower embodied energy and related GHG emissions (Arshan, 2017).

In current techniques, blended materials, the most prevalent of which is fly ash, commonly replace up to 30% or more of the Portland cement (Darko et al., 2013). By-products like fly ash and blast furnace slag are available in different regions. They were first sold for a low price, which decreased the cost of cement. As a result of increased demand, this is currently changing in many areas. They were also thought to be CO₂-free (UN Environment Programme, 2016). Using green cement in construction projects in Lagos megacity reduces the carbon emissions associated with cement production, contributing to mitigating climate change and promoting sustainable development. This aligns with global efforts to reduce greenhouse gas emissions as outlined in the United Nations Sustainable Development Goals (SDGs), particularly SDG 13 on climate action. According to Imbabi et al. (2013), if carbon-reducing cement could be created for use on a large scale, it would likely offer the safest, most practical, and most beautiful Carbon Capture and Storage (CCS) technology. However, the CO₂ emissions from cement manufacturing were predicted to rise by 260% between 1990 and 2050 under a "business as usual" (BAU) scenario.

Social, economic and environmental benefits of Green Cement

The cement industry would be held accountable if new techniques for lowering CO₂ emissions from cement production are not put into practice in 2050 for around a third of this target amount. Green cement, with its reduced carbon emissions and use of alternative materials, can help reduce such pollution impacts, leading to improved air and water quality (Naqi & Jang,

2019) in Lagos, which is critical for the health and well-being of its inhabitants. In addition to its environmental benefits, green cement can also have social and economic impacts on the Lagos megacity. The use of green cement in construction projects can promote local job creation and economic development (International Labour Office, 2013) by stimulating the growth of industries that produce alternative materials such as fly ash or slag. This can help diversify the economy, reduce dependence on traditional cement production, and create new opportunities for local communities (UNDESA, 2013) in Lagos.

In addition to its environmental benefits, green cement can also have social and economic impacts (Reid & Houston, 2013) on the Lagos megacity. Furthermore, green cement can also contribute to resource conservation (Akadiri et al., 2012) in the Lagos megacity. Traditional cement production requires extensive mining of raw materials such as limestone and clay, which can result in habitat destruction, deforestation, and loss of biodiversity (Dhingra, 2021). Green cement, by utilizing alternative materials and waste products, can help reduce the demand for these raw materials, leading to the conservation of natural resources and the protection of local ecosystems in Lagos.

Construction industry on sustainable development of Lagos megacity

The construction industry is the brain of the development of cities in the world. The construction industry's performance in any infrastructure, such as public and commercial buildings, has a significant negative impact on our ability to maintain sustainable development generally and has a significant negative impact on our environment (Wangchuk et al., 2013). Sim & Putuhena (2015) opined that environmentally sustainable development construction calls for creative solutions that improve sustainability and produce outcomes that are beneficial to all. UN Environment Programme (2016) explained that the building industry is a significant user of cement and other natural resources and a major contributor to meeting the needs of houses, schools, hospitals, and public and commercial developments.

Also, "Habitat for Humanity" (2021) put forward that housing is a must for cities to be inclusive, equitable, safe, resilient, and sustainable. According to UN Environment Programme (2016), materials based on cement will continue to be necessary for the expansion and enhancement of our built environment, especially for those living in developing countries. Hence, the building industry is getting more attention from global sustainable development regulations because of its high energy use and greenhouse gas emissions (Berardi, n.d.). However, cement production generates various types of pollution, including air pollution from

dust and emissions, as well as water pollution from mining and the transportation of raw materials (Arachchige et al., 2019b).

As cities and national governments work to meet their sustainable commitments, they must balance huge infrastructure needs with environmental concerns and emerging resource constraints. New building materials and innovative approaches will be needed. Conventional building materials like cement and steel use a lot of energy to produce them, which worsens global warming and undermines sustainability. Low-carbon building materials are proposed to address the housing challenge in cities (GGGI, 2019). The construction sector can actively and positively contribute to environmental protection through the notion of sustainable construction (Umar & Khamidi, 2012).

Statement of the research problem

In a bid to achieve a sustainable Lagos Megacity, the place of the construction industry cannot be overlooked. The daily increase in the number of construction due to rapid rural-urban migration in search of greener pastures put a demand on the city to provide the infrastructure that will accommodate the ever-growing number. This brings about the need for cement on a high scale and Ordinary Portland cement (OPC) is in use majorly as people are uninformed of what green cement is and its advantages. Green cement according to *Cement Is the New Coal*, n.d., is leading the way in cutting-edge technology to reduce carbon emissions from building materials. However, the level of awareness of green cement to ordinary Portland cement is still far even among professionals.

Green cement has social, economic and environmental benefits to society in several ways. These benefits have to be harnessed for a better Megacity. Imbabi et al. (2013) opined that when alternative low-carbon cement or concretes are introduced into the market, three factors will determine whether they will be successful or not; first, they are practical and perform well in both short-term and long-term applications; second, there is sufficient scientific evidence to validate the product's capabilities so that it meets engineering standards for particular uses, such as the production of cavity blocks and ready-mix for in situ cast of foundations; and third, there is enough raw material available to transport to processing plants in bulk. Aside from the numerous benefits are also barriers and setbacks to the acceptance and adoption of green cement in Lagos megacity sustainable development. Hence the need to assess these barriers from professionals within the built industry.

Methodology

A quantitative research method was used in the form of a survey questionnaire administered to building industry professionals (BIPs) in Lagos Mega City to assess their perception of green cement and its potential for sustainable development. The building industry professionals that filled out the questionnaires cover Architects, Builders, Quantity Surveyors, Estate Surveyors and Valuers and Structural Engineers living in the five divisions of Lagos Megacity comprising Ikorodu, Badagry, Epe, Lagos Island and Lagos Mainland. A set of structured closed-ended questions were administered through the Google platform. 121 responses gotten was coded and analyzed using statistical techniques for Social Sciences (SPSS). All respondents were free of any manipulation as the total number received was analysed and interpreted. The anonymity of all respondents was kept as none were forced to answer without their consent.

Results

The term ‘green cement’ seems not to be alien to many within the built environment. This was confirmed by the responses gathered in the study. 62% of the respondents have lived in Lagos for over 10 years. The percentage of those without idea seems low as than 16% leaving a higher percentage of 41% having fair knowledge of the term. 43% went with all of the above making a guess of what exactly green cement is. This was displayed in

Table 1: Knowledge of Green Cement

Table 1:

Questions	Frequency	Per cent	Cumulative Percent
All of the above	52	43.0	43.0
Cement that has a low environmental impact	7	5.8	48.8
Cement that reduces carbon emissions during production	17	14.0	62.8
	26	21.5	84.3
	2	1.7	86.0

Environmentally friendly cement made from recycled materials	17	14.0	100.0
None of the above	121	100.0	
Not sure			
Total			

The knowledge of green cement has translated into an awareness of its availability of usage. The widespread knowledge and usage of Portland cement which is hazardous to the environment with the release of greenhouse emissions has overshadowed green cement. The level of awareness is presented in Table 2 below. Only 24% of the respondents are familiar with the term leaving 76% that are yet to hear about it or heard without a full understanding of what it is. The level of familiarity gave a better understanding as the 43% that subscribed to all of the above in Table 1, only did with little or no knowledge of the term “green cement”.

Table 2: Familiarity with green cement

Questions	Frequency	Per cent	Cumulative Percent
No, I haven't heard about it	40	33.1	33.1
Yes, I am familiar with it	29	24.0	57.0
Yes, I have heard of it but not familiar with it	52	43.0	100.0
Total	121	100.0	

The low level of awareness among professionals in the built environment has revealed the low knowledge of what green cement is. This will naturally translate to the general public as those within the profession are expected to spearhead the awareness.

Table 3: Social, economic and environmental implications of Lagos megacity sustainable development

Questions	Frequency	Per cent	Cumulative Percent
All of the above	57	47.1	47.1
Conservation of natural resources	6	5.0	52.1
Energy efficiency	4	3.3	55.4
	2	1.7	57.0

I don't know	6	5.0	62.0
Improved building durability	8	6.6	68.6
None of the above	29	24.0	92.6
Reduced carbon emissions	9	7.4	100.0
Reduced environmental impact	121	100.0	
Total			

Environmental implication or advantage of green cement to a sustainable Lagos Megacity seems to top the list as 24% and 7.4% respectively believed the use reduces carbon emission release and reduction in negative environmental impact. The other factors of economic and social are yet to be fully expressed. The energy efficiency which pulled just 3.3% is of low significance economically according to Table 3 above. However, improved building durability and conservation of natural materials both came up with 5% approval from the table

Table 4: Challenges and drawbacks of the implementation of green cement

Questions	Frequency	Per cent	Cumulative Percent
All of the above	55	45.5	45.5
Higher cost compared to traditional cement	7	5.8	51.2
I don't know	1	.8	52.1
Insufficient government policies and regulations supporting green cement	3	2.5	54.5
Lack of awareness and education about green cement	37	30.6	85.1
Limited availability of green cement in the market	11	9.1	94.2
None of the above	7	5.8	100.0
Total	121	100.0	

Challenges to its adoption and usage was highlighted in Table 4. Topping the list is the lack of awareness and education about green cement. The infiltration of the cement market with common brands of Portland cement has left no room for this sustainable alternative. The acceptance is due to low knowledge of the availability of the material in the market. 9.1% opined on the limited availability of the material as those with the knowledge find it difficult to get it even when they are ready to make use of it. Hence the need to increase production to allow accessibility for purchase and use.

Discussion of Findings

The knowledge and the level of awareness of what green cement is seems to be foreign to professionals in the built environment with over 76% acknowledging their little or no knowledge of the term. However, despite the low awareness level, and difference in opinion on impact, a close look suggested acceptance of his positive environmental benefits to Lagos Mega City's sustainable development. Green cement has a positive impact on the environment, with 24% acceptance of its ability to reduce carbon emissions and 7% inferring that it reduces the negative impact on the environment. The green cement impact on the environment and the environmental benefits of green cement for the sustainable development of Lagos megacity seem to be at the top of the list. 24% believe that it reduces carbon emissions and 7% said it reduces the negative environmental impact. However, the cement market is saturated with well-known brands of Portland cement, leaving no room for this eco-friendly alternative. This acceptance is due to a lack of awareness of the material's availability in the market. Only 9.1% commented on the limited availability as those with knowledge of the material find it hard to obtain it even when they're ready to use it. Therefore, increasing production is necessary to make it available for purchase and use.

Conclusion

In conclusion, green cement has the potential to positively impact sustainable development in Lagos megacity by reducing carbon emissions, mitigating pollution, conserving resources, and promoting social and economic development. By adopting and promoting the use of green cement in construction projects, Lagos can contribute to global efforts towards sustainable development and address the environmental and socio-economic challenges associated with urbanization and rapid development.

Recommendations

A sustainable Lagos megacity is feasible with the introduction of green cement in place of Portland which has more negative environmental impact on the society. Policymakers, entrepreneurs, and industry experts all have to come together to embrace and propagate its use. This can be achieved by:

- 2 Awareness and education on green cement as an alternative binder.
- 3 Sentization on the benefits of green cement.
- 4 Integration of green cement to government projects for wider use.

These will help in furthering the acceptance and usage of green cement in construction to the development of a sustainable Lagos Megacity.

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