IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 21, Issue 3 Ser. 1 (May. – June. 2024), PP 64-72
www.iosrjournals.org

Sustainable Material Sourcing for Marine and Coastal Infrastructure: Challenges and Innovations

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Abstract - *This literature review introduces the changing environment of sustainable materials in the marine and coastal infrastructure field, addressing the most critical issues and innovative solutions that contribute to the domain. Because coasts and marine areas are becoming particularly vulnerable to climatic changes, rising sea levels, depletion, and dwindling resources, there is an urgent need to implement environmentally responsible and resilient construction materials and construction sourcing practices. In their review, they thoroughly look at numerous peer-reviewed articles and conclude on the state of practices at the present and many of the critical barriers they encountered along the way including those of material availability, long-term performance data, economic limitations, and the lack of uniform regulatory systems. Corresponding to the proposals, the literature introduces new innovative solutions such as using recycled aggregates, bio-based composites, and green concrete, as well as improving the digital tools and the manufacturing process itself to ensure a more energy-efficient and lower-carbon production. Alternative types of sourcing are also becoming popular solutions to the local materials issues, upcycling, and local material use solutions are also becoming more common. The review ends with the component of the strategic significance that the sustainable sourcing of materials will have in the process of determining the durability, affordability, and environmental sustainability of marine and coastal structures in the future. It demands closer cooperation between researchers, industry professionals, and policymakers to reduce current research gaps and speed up innovation, thus strengthening the sector's position in support of global sustainability targets.*
Keywords: *Sustainability, Marine Infrastructure, Coastal Construction, Sustainable Material Sourcing, Innovations in Construction.*

I. INTRODUCTION

Green building has become a major debate in the quest by the world to stem environmental destruction, exploitation of resources, and climate-related issues. This is an especially pressing issue in the environment of marine and coast infrastructure where structural environments are in direct interaction with vulnerable ecosystems and exposed to more intense weather, sea-level rise, and salt corrosion. Coastal and marine infrastructure, unlike that on land, should be developed in such a way that the infrastructure should not cause much disturbance to the environment. This necessitates the switch to sustainable construction methods, particularly when it comes to the acquisition of materials, which is considered a vital aspect of the environmental impact and the resilience of such projects in the future. Sustainable material sourcing entails choosing and sourcing renewable, recycled, locally available materials processed using low-carbon methods. The significance of selecting materials that are durable, and, at the same time, ecologically accepted cannot be overestimated, especially in harsh sea conditions where the information on material degradation can be really shocking.

Although there has been an increasing interest in the subject, there still exists disaggregated information regarding the predicament of finding sustainable sources of materials in a coastal environment and the emerging innovations responding to the predicament. The current literature is divided into different fields: environmental engineering, materials science, and urban planning, which complicate the ability of the stakeholders to obtain a consolidated knowledge of the best practices. Thus, the literature review is justified to critically review the existing body of knowledge, recount the common barriers, evaluate the technological and material progress, and formulate the questions, which demand additional research.

This review covers a detailed discussion of the following specifics the critical challenges in sustainable material sourcing, especially the shortage in supply chains, pricing issues, and a general lack of standardization, and, in addition, the recent developments and their implementation, including the application of recycled aggregates, bio-based materials, green concrete, and digital optimization. It also looks at the performance attributes of these materials in extreme marine conditions where some factors such as salinity, humidity, and wave actions may have significant effects on longevity and maintenance treatment. Case studies used in the review illustrate practical approaches and appraise how the production processes and sourcing plans can be enhanced in an environmentally and economically efficient way. Finally, the mission of the review will be to guarantee an overall picture of the present reality of sustainable sourcing of materials in marine and coastal buildings. It aims to establish gaps in the existing studies, outline the applied and technological novelty, provide evidence-based comprehension to researchers, practitioners, and policymakers, and make valuable choices. This review is hoped to assist in making the development of more sustainable, resilient, and affordable coastal infrastructure development worldwide, but synthesizing an extensive extent of the literature may add value.

II. METHODOLOGY

To be able to arrive at a robust and broad comprehension of the sustainability of material sourcing in marine and coastal infrastructure, the systematic and transparent choice-making process was used in the current literature review. The search strategy was developed so that it included peer-reviewed scholarly research, conference proceedings, and institutional reports related to the topic. Four large scholarly databases Scopus, ScienceDirect, Google Scholar, and JSTOR were used. The considerations made in order to filter relevant materials were the following keywords and Boolean strings: sustainable material sourcing, coastal infrastructure, marine construction materials, eco-friendly building materials, bio-based materials, and green concrete in marine environments. The use of Boolean operators like AND and OR allowed for narrowing down the results and capturing the overlapping-themed studies. Also, snowball sampling was implemented by looking through the reference lists of the most relevant articles to find additional studies that were not found via database search [8].

The selection criteria were well formulated in making sure that the literature was recent and subject to interest. The inclusion criteria were as follows References [6]: (1) the study was published in 2005-2023 (as a reflection of current developments), (2) it specifically targeted the application, performance, or evaluation of sustainable materials in marine and coastal infrastructure, (3) the study was peer-reviewed to ensure the academic level of credibility, (4) the study had clear methodologies and results regarding the sources of the materials, environmental performance of the materials, or lifecycle analysis. This made it possible to conduct a selective examination of the works in which they intersected in terms of both technical quality and relevance to the problem of practical implementation in severe marine conditions [9].

Conversely, exclusion criteria were used to exclude studies that were not in tandem with the scope of the review. These were (1) publications not related to marine or coastal construction (including those that only did inland- or earthbound-based green materials); (2) non-peer-reviewed sources (including editorials, opinion pieces, and blogs); (3) studies that were earlier than 2005, likely not addressing current innovations or regulatory environments; and (4) publications that contained inadequate data and had inadequate analysis, which would include: having no measurable outcomes of performance, sourcing strategies, or environmental impacts. The study methodology was focused on thematic analysis, which can be described as a qualitative approach that entails apprehending, classifying, and making interpretations in aspects of pattern finding in the chosen studies. This made it possible to structure the literature into some main themes which include material availability, environmental performance, technological innovation, cost-effectiveness, and policy implications. The themes were identified by examining each study to draw a comparative idea of similarities and differences between geographic areas and the type of materials. In others, an additional approach was used, namely comparative review, to point out differences in the findings of traditional and emerging sourcing practices, thus contributing to enhancing the result of the literature review [16],[3].

Table 1: Summary of Methodology for Literature Selection

Methodology Component	Description
Search Strategy	Comprehensive search across Google Scholar, Scopus, ScienceDirect, and JSTOR using keywords related to sustainable material sourcing, marine infrastructure, and coastal construction.
Inclusion Criteria	Peer-reviewed sources, publications from 2005-2020, research directly addressing sustainable material sourcing in marine and coastal infrastructure, and studies with clear methodology and analysis.
Exclusion Criteria	Non-peer-reviewed sources, studies not relevant to marine/coastal environments, publications before 2005, and studies lacking sufficient data or methodology.
Analysis Approach	Thematic analysis to identify key themes such as material availability, performance, economic barriers, and technological innovations.

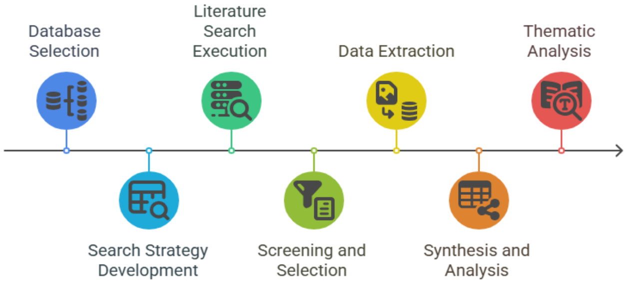

Fig 1: *PRISMA-style flowchart of the literature review process from database selection to thematic analysis*

III. CHALLENGES IN SUSTAINABLE MATERIAL SOURCING FOR MARINE AND COASTAL INFRASTRUCTURE

Selection of sustainable materials to use in marine and coastal infrastructure is a complex issue that involves consideration of environmental and technical issues. Among the major challenges facing the implementation of sustainable materials is the availability of materials that are not only environmentally friendly but also match the challenging marine performance needs. Concrete and steel as well as other conventional materials are effective, but they exert serious effects on the environment as they require enormous amounts of energy to manufacture and thus, cause excessive sources of carbon emissions and scarcity of resources. An example is concrete, which sees a lot of the total carbon worldwide being emitted into the environment due to the emission of around 8 percent of the total CO2 in the world. Their use in marine and coastal areas, where they can also be exposed to corrosion and degrade under exposure to seawater and extreme weather, also poses performance problems resulting in increased maintenance costs and the shorter lives of infrastructure components [21]. Another major impediment is presented by the presence of sustainable alternatives. Even though new inventions of unique materials are emerging, including bio-based materials and recycled aggregates, their application cannot be spread much because of the supply chain issues, scalability, and reliability of the new material production. Reused materials like recycled ones can be viewed as unreliable regarding consistency and quality compared to virgin ones, and the builders have fears regarding the durability of the structures made of materials obtained by recycling. Furthermore, some sustainable materials may be costly in comparison with conventional ones because the technology used to create new materials has not reached its optimum; that is, it does not have that kind of economy of scale that the traditional building materials have [26] .

The other main problem is the synergy of sustainable material sourcing with its regulations and policies. Although most regions and countries have established strict environmental policies, there are no common working principles and certification standards that would use sustainable materials in the marine and coastal infrastructure. When there is no unified and clear legislation, sustainable sourcing can be uneven because some projects worked on may decide to use materials that are less costly and more environmentally unfriendly in order to afford smaller budgets [29]. Moreover, it is possible that the commitment of the local governments and the construction sector might not be the same and in the developing regions in the majority of cases, the economic factors are most likely to determine the priorities rather than the environmental ones [20]. Lastly, the efficiency and stability of sustainable materials in extreme marine conditions continue to be a tongue-twister. Marine infrastructure is exposed to saltwater, UV radiation, and high temperatures all of which may aggravate the wear and tear of materials. This is because it is important to take care of sustainable materials so that they can last long. As an example, even though bio-based composites have a good potential as a sustainable material, there is still a significant lack of research and testing regarding their stability in saltwater, as well as their aptitude for constant exposure to coastal environments [11]. It is essential to respond to these issues because such changes in materials ensure that the traditional ones can be successfully substituted with sustainable ones in marine and coastal construction projects.

Table 2: Challenges in Sustainable Material Sourcing for Marine and Coastal Infrastructure

Challenge	Description	Impact on Sourcing
Material Availability	Limited supply of eco-friendly and durable alternatives to traditional materials.	Hinders large-scale adoption of sustainable materials.
Performance Reliability	Sustainable materials often have inconsistent quality or unproven durability in marine environments.	This creates concerns about long-term performance and integrity.
Economic Barriers	Sustainable materials can be more expensive due to the high costs of production and limited economies of scale.	Increases overall project costs, deterring widespread adoption.
Regulatory and Policy Gaps	Lack of clear and standardized regulations for sustainable materials in marine infrastructure projects.	Inconsistent implementation of sustainable practices across projects.

Durability Concerns	Sustainable materials may not perform well in harsh marine environments, such as saltwater corrosion.	Shortens lifespan and increases maintenance needs for infrastructure.

IV. INNOVATIONS IN SUSTAINABLE MATERIAL SOURCING

With the growing need for coastal and marine infrastructure that should be more environment-friendly, the necessity of innovative approaches to material sourcing is becoming more urgent. Coastal projects with harsh marine environments usually do not fulfill sustainability demands that need the traditional construction materials to be long-lived and resistant to harsh marine environments. In turn, extensive progress has been achieved with regard to creating sustainable materials that would cause less harm to the environment, be immensely lasting, and in terms of resourcefulness. In this paragraph, the most important innovations such as working with recycled aggregates, bio-based materials, green concrete, and the implementation of advanced technological tools are discussed. Throughout the analysis of those innovations, we will spotlight their opportunities to reshape the practice of material sourcing, enhance the impact of coastal construction on the environment, and gradually develop a more sustainable future of marine infrastructure.

A. Innovative Materials

Because of recent advances in the research field, some new materials have been developed that are increasingly incorporated into marine and coastal infrastructure works to enhance sustainability. The use of recycled aggregates in the production of concrete is one of the major areas of development. Aggregates like crushed concrete or other waste materials can be recycled and used as recycled aggregates, the use of which will consume less virgin materials and waste materials taken into a landfill. Moreover, bio-based materials including bamboo, hempcrete, and mycelium have also attracted attention because of their low environmental impact and the possibility of applying them in the structural field. The materials are sustainable, they can be locally sourced and decompose (biodegradable), and are thus the best candidates for sustainable construction in marine settings. Moreover, green concrete, produced with alternative binders, including fly ash and slag, has proven to be an outstanding candidate both in terms of environmental outcomes and performance in harsh environments, such as on the coasts and in seas as an alternative to usually used concrete [10]. In the same manner, the production of these materials using environmentally friendly technological solutions has improved, with literature focusing on the concept of utilizing recycled materials in buildings [22].

B. Technological Advancements

Besides coming up with new materials, technologies have transformed the manner in which sustainable materials are identified and streamlined for marine and coastal projects. Digitalization, artificial intelligence (AI), and automation in construction have allowed controlling materials more accurately and efficiently. As an example, AI-enabled tools are currently being developed to forecast the location and the price of sustainable materials which allow the project managers to make informative decisions to produce less harm to the environment and consume materials efficiently [5]. Automating processes of resources like materials recycling has also been a major idea in making sure that the level of material efficiency is improved, waste which is another important issue today reduced, and Carbon emissions are most importantly minimized. The performance of materials is not the only aspect of these advancements; they promote more sustainable and low-carbon ways of construction [17].

C. Alternative Sourcing Techniques

Sustainable sourcing methods are also being used in marine and coastal infrastructure schemes especially where other sources of materials are unsustainable or impossible. Upcycling is one of the promising methods to reuse materials in the form of waste and transform them into new higher-value uses. In the sea coastal regions, recycled glass and plastic have been applied to produce recycled aggregates, which are environmentally friendly and provide a sustainable source in the place of mining aggregate [17]. The second method is the use of local materials, which lowers the number of emissions due to transport and contributes to the local economy. Coastal architecture can be done with local stone, clay, and wood materials, reducing the footprint left by coastal construction on the environment due to the transportation of long-distance materials. Another alternative technology that employs living plants and natural fibers to strengthen construction materials enhancing the performance of the materials and sustainability in the environment is bioengineering [24].

D. Eco-friendly Manufacturing Processes

Parallel to the invention of materials that are more sustainable, new technologies in eco-friendly production processes are also making a meaningful contribution to the sustainability of marine and coastal infrastructure. The shift towards low-carbon modes of production is one of the primary steps made. As an example, an alternative binder such as geopolymers can be used in concrete that has lowered carbon emitting up to 80 percent of those produced by conventional Portland cement. There are also energy-efficient production processes that are being increasingly adopted, e.g. using renewable energy sources in the manufacture of materials, closed-loop water systems in concrete mixing, etc. The applications minimize the environmental cost of production and activities and make sure that the materials applied to building constructions along the coast follow deficit-free approaches as much as possible.

E. Case Studies of Successful Innovations

General announcements of several successful case studies show that the implementation of these innovations in real marine and coastal infrastructure projects is effective. Another well-known case sample is that of green concrete being used to construct a new coastal highway in the UK, with green binders limiting the environmental impact of the project on mode-1 carbon to retain its durability in marine locations [15]. The other successful practice is the upcycling of waste plastics into environmentally friendly construction materials for a seawall project in the Netherlands. At the same time, the project saved waste, as materials produced with it included recycled plastic in the recipe, which made it a long-lasting and environmentally sustainable coastal defense. These instances show that in the future all aspects of coastal construction can change with the help of innovative materials and sustainable techniques of sourcing [18] .

V. PERFORMANCE AND DURABILITY OF SUSTAINABLE MATERIALS

It is a special concern how sustainable materials perform and last longer in marine and coastal infrastructure because the environment exposes them to high demands. The marine environment also brings out its own sets of complex problems where the Saltwater corrosion, the excessive moisture of the environment, the exposure to the UV rays, the varying temperatures, and the eddying of the environment are all there. It is these factors that with time could substantially deteriorate the materials being used unless given due consideration during the stages of selection and design. Research has indicated that even though traditional building materials such as steel and ordinary Portland cement concrete are strong, coastal regions lack durable materials because they tend to deteriorate quickly due to chloride penetration and corrosive conditions [2]. Conversely, other versions of green concrete that include fly ash, ground granulated blast-furnace slag (GGBS), or geopolymers have better chloride infiltration resistance and offer low rates of carbonation, resulting in a longer lifespan of concrete in marine environments [27]. In a similar way, composites that incorporate fiber reinforcement and bio-based polymers have exhibited good opportunities for resisting UV deterioration and brittleness due to salt in long-term marine service tests [30]. In order to prove their resistance, sustainable materials are put to the accelerated test that imitates years of weather conditions in a small amount of time. Some common evaluation methods are accelerated weathering tests, which simulate the harsh environmental factors (UV light, salt fog, and thermal cycling), freeze-thaw simulations, which are meant to test how a material can withstand temperature changes, and material fatigue testing which is used to determine the impact of repeated loading in the structure [12]. On concrete works, Rapid Chloride Permeability Tests (RCPT) and sulfate resistance tests are conducted to determine the performance of alternative binders and aggregates in comparison to saltwater infiltration.

In the case of polymeric and composite materials tensile strength preservation and the occurrence of micro-cracks with fatigue are important predictors of long-year life. These procedures play a critical role in pre-qualifying materials which are to be used in strict conditions. A number of field case studies provide beneficial information on how well performing and what is learned during the implementation of sustainable materials on coastal constructions. As an example, the Jubail Industrial Port in Saudi Arabia used fly ash blended concrete on its wave barriers. In conclusion, the structures had a remarkably low level of chloride content at different depths after 10 years than control sections when they used a conventional concrete long-term effectiveness of blended cement in inhibiting permeability [1]. Conversely, a pilot seawall built in Southeast Asia using early bio-composites showed excessive wear of the surface and fungal growth with the need for more anti-fungal treatment and better resin formulations with bio-based ingredients. These illustrations support the overall significance of choosing the appropriate materials to be used but also warn about the adequacy of choosing some form of protective treatment and maintenance strategies that could enhance the lifecycle of green construction solutions.

Table 3 : Summary of Sustainable Materials Performance in Marine Environments

Material Type	Environmental Resistance	Durability Highlights	Limitations
Fly Ash/GGBS Concrete	Excellent against chloride penetration	Lower permeability, better sulfate resistance	Requires strict mix control
Geopolymer Concrete	High resistance to chemicals and corrosion	Minimal shrinkage reduced CO_2 footprint	Limited large-scale field data
Fiber-reinforced polymers (FRP)	Good UV and moisture resistance	High tensile strength, low maintenance	Sensitive to temperature extremes
Bio-based Composites	Moderate salt and UV resistance	Lightweight, biodegradable	Prone to biological degradation without treatment
Recycled Aggregate	Moderate durability with proper	Sustainable, reduces landfill	Risk of inconsistent quality from

Concrete	mix design	burden	source materials

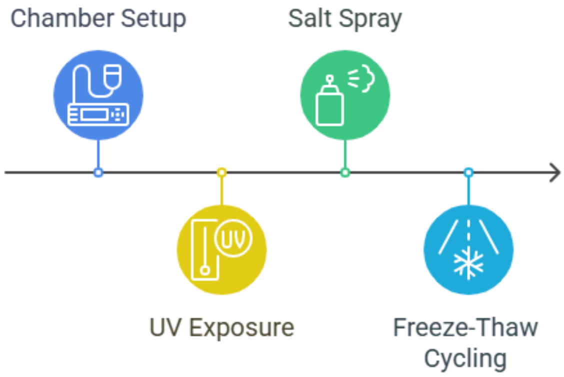

Fig 2: Accelerated weathering chamber setup for UV, salt spray, and freeze-thaw cycling of composite samples

VI. POLICY, REGULATORY, AND INDUSTRY TRENDS

Global and local policy trends are very important in implementing sustainable material sourcing measures in the marine and coastal infrastructure, as they form part of the regulatory regime in which construction projects are to be executed. Internationally several conventions and agreements have been signed like the Paris Climate Accord, and the UN Sustainable Development Goals (SDGs), which have appeared to influence national governments to impose policies that will advance lower-carbon-emissions built methods and utilize materials that are more environmentally friendly. To give an example, the European Union Green Public Procurement (GPP) guidelines highly encourage using recycled or renewable materials in any public construction (coastal defenses and ports) and other jobs [7]. At the the local level, coastal countries with vulnerable coastlines, like the Netherlands, Bangladesh, and the Philippines have already started considering sustainability criteria in state-level coastal development plans with the life-cycle assessment of the material used and environmental impact analysis being a prerequisite to sanctioning coastal infrastructure development.

Simultaneously, sustainability standards and certifications have been among the key aspects that have influenced the shift in the practice of material sourcing within the construction industry. Other estimations, including LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Method), and ENVISION are well-known platforms that offer guidelines on organizing an assessment of building materials, energy consumption, water use, construction, and so on. The LEED rating system and BREEAM both give credit to utilizing recycled content, building materials that resemble attention to local resources, and low-emitting building materials, all of which are significant to constructing on the coast [28]. More recently, newer certifications, including Living Building Challenge, also take the further push toward net-positive effects on the environment, and regenerative design practices. In marine conditions, specific standards, including ISO 16304 and ISO 21650, devoted to coastal infrastructure planning and sustainability-driven performance, may serve as the guiding values on the material sourcing and project design that have to be performed under salty, humid, and severe marine conditions [13].

Although the industry adoption rate of sustainable materials to construct the coastal there is a very anomalous trend and it is dependent on a number of factors irrespective of current progress in the policy development and certifications. These are cost-effectiveness, material performance, and regulatory enforcement, which are among the key drivers. Sustainable materials are still seen as costly or in better terms unproven compared with their traditional counterparts in certain applications, particularly in high-stress applications such as seawalls, piers, or offshore platforms [4]. Nevertheless, government incentives e.g. tax subsidies, grants, or fast-tracking of permits are the main contributors to the enhanced adoption of green practices in areas where governments take action. In addition, it is often easier to implement these standards in the presence of public sector projects owing to the regulatory requirements, whereas, in the case of the private sector, it largely depends on the prestige factor and the cost savings in the long run of having sustainable operations [25]. However, increasing concern is being expressed that the up-front costs of incorporating sustainable materials are frequently recouped in the long run due to spare maintenance costs, extended shelf life of materials, and low environmental debt.

Table 4: Summary of Policy, Regulatory, and Industry Trends in Sustainable Material Sourcing

Trend Area	Key Focus	Impact on Sustainable Sourcing

Global & Local Policy	Paris Accord, UN SDGs, national green building codes, coastal development frameworks	Encourages or mandates the use of sustainable materials through regulations
Certifications & Standards	LEED, BREEAM, ISO 16304, Living Building Challenge	Guides project design and material selection toward low-carbon, high-performance options
Industry Adoption	Cost, incentives, performance, and reputation as adoption drivers	Affects real-world implementation; and varies by region, sector, and project funding

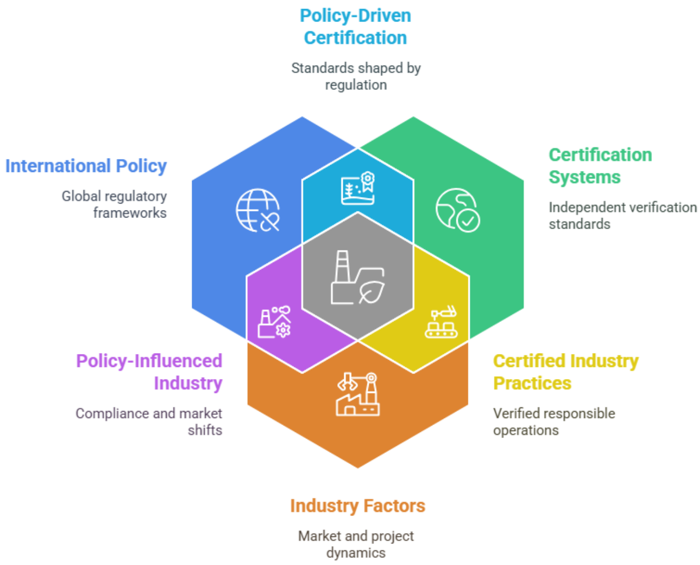

Fig 3: *Overview of how policy, certification, and industry factors influence sustainable material sourcing in coastal construction*

GAPS IN CURRENT RESEARCH AND FUTURE DIRECTIONS

Although increasing interest is taking place in sustainable construction approaches towards marine and coastal infrastructure, substantial gaps remain in the existing literature. Among the biggest weak spots is the fact that there is little long-term data available on the performance of emerging sustainable materials that have been implemented in marine settings. Most of the studies concentrate on small-scale results carried out in the laboratory, yet little field data exists on how such materials cope under long-period harsh environment conditions such as saltwater corrosion, wave loading, and biofouling. Besides, no study has been conducted on how bio-based and recycled materials behave in severe weather conditions, like hurricanes or an increase in sea level, which is highly likely to occur because of climate change. The economical-feasible and life-cycle cost of alternative materials is another gap to be considered. Although environmental gains are mostly appreciated, the majority of examinations overlook entirely the cost impact of transferring to sustainable materials, i.e., production, transportation, maintenance, as well as any kind of recycling at the end of the road. Furthermore, work on standardization and certification of new materials is minor and it will be problematic to deploy the materials to large-scale infrastructure projects.

Irregular or lack of standards will compromise the trust in the adoption of alternatives by the stakeholders. In order to aid such gaps, future studies must consider the development and testing of the next-generation materials possessing superior durability, affordability, and environmental characteristics. It encompasses the development of hybrids as well as biodegradable reinforcements and smart materials which can self-heal as well as monitor their condition in real time. Also, there is an absolute necessity for full-scale pilot projects and longitudinal studies that track the behavior of these materials within the marine environments in longitudinal studies. The region-based solutions also should be researched, particularly in developing countries, which have little access to high-tech materials, or energy-intensive modes of production. Digital integration and AI modeling need to be researched in the future to forecast the degradation of materials, the potential of supply chain optimization, and environmental impacts. Researchers can use lifecycle simulation of materials in different coastal environments to assist designers and engineers in making a more informed selection of materials. The technologies also can assist in real-time environmental sensing with the possibility of adaptive application of materials depending on environmental changes.

On a more feasible and policy-related dimension, one of the biggest restrictions on the current practice is the absence of integrated policy frameworks that require or encourage sustainable sourcing in marine constructions. Regulatory organizations and governments should come up with healthier sustainability standards, unitary product testing methodology, and material certification frameworks. Industrial players ought also to participate in networking with researchers to test solutions and best practices that can be shared on a global level. A faster entry into the industry could also be ensured by introducing financial incentives like green construction tax breaks or subsidies for the use of recycled materials.

Table 5: Summary of Research Gaps and Future Directions

Category	Identified Gaps	Future Research Needs / Recommendations
Performance Data	Lack of long-term field data for sustainable materials in marine environments	Longitudinal studies on real-life performance under saltwater, UV, wave forces, and biofouling
Economic Analysis	Limited lifecycle cost analysis for bio-based and recycled materials	Cost-benefit evaluations including maintenance, durability, and end-of-life scenarios
Standardization	Inconsistent testing and certification standards for sustainable materials	Develop international testing protocols and standard material certification systems
Technology Integration	Minimal use of AI or digital modeling for sourcing and performance prediction	Develop predictive tools and digital twins for material behavior simulation.
Policy and Governance	Weak regulatory frameworks and few incentives for sustainable sourcing	Develop cohesive policies, offer green construction subsidies, and promote global collaboration

VII. CONCLUSION

The undertaken literature review has demonstrated how essential the sustainable sourcing of materials is in the promotion of environmentally responsible marine and coastal infrastructure. Important findings show that even though a good deal of progress has been achieved with regard to the creation of innovative materials including recycled aggregates, green concrete, and bio-based materials- there is still a long way to go. They are a shortage of long-term performance data, economic feasibility, insufficient standardization, and poor regulatory support. The use of technologies, such as AI-enhanced resource optimization and energy efficiency in the production process, area, can promise optimized material use and less environmental impact of marine construction. In addition, other sourcing methods like upcycling along with the utilization of resources locally found in the area have been proven to be relevant in context and practical, particularly in situations of low resources. Through the literature the gaps that still exist in the research can be seen, including field testing on a large scale, the life-cycle cost analysis, and the integration of computer tools to model long-term performance so that these gaps can be filled in the future. The relevance of this review consists in the fact that it summarizes not only new tendencies but also existing constraints that can receive a guide to the way sustainable material sourcing can support climate-resilient, economically softer, and more environmentally conscious coastal development. In order to achieve this potential, we have to engage in a concerted action by the researchers, policymakers, and industry professionals is essential. It is imperative to develop robust certification systems, invest in interdisciplinary research, and establish policy frameworks that incentivize sustainable practices. Through collaborative innovation and informed decision-making, the construction industry can ensure the sustainability and longevity of future marine and coastal infrastructure.

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