World Journal of Advanced Research and Reviews

eISSN: 2581-9615 CODEN (USA): WJARAI

Cross Ref DOI: 10.30574/wjarr

Journal homepage: https://wjarr.com/

(Research Article)

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Critical factors for implementing sustainable construction practices in project delivery and management

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World Journal of Advanced Research and Reviews, 2024, 24(08), 2658-2675

Publication history: Received on 06 November 2024; revised on 21 December 2024; accepted on 23 December 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.24.3.3842

Abstract

Introduction/Background: The construction Industry is central to world economic growth and the ongoing process of urbanization. However, it is also an environmental problematic area as it causes pollution, resource depletion and emission of the greenhouse gases. Modern construction is experiencing significant concerns with sustainability hence the need to shift from the conventional construction practices and embrace sustainable construction. This paper looks at key issues based on construction project delivery and management for sustainability. It also focuses on how the industry can maintain the triple bottom line of sustainability in the different phases of project life cycle.

Materials and Methods: This research uses literature review as the method for integrating and analyzing the existing knowledge in the construction sustainable practices. Both qualitative and quantitative data collection methods were used in the present study and the most relevant sources of information consisted of peer-reviewed journal articles, industry reports and literature as well as sustainability assessment tools were also used to analyse the findings and identify the major themes and effective measures in the field. The study focuses on three main areas: A)Functions of construction business in sustainable development, B)Measures towards improving sustainability in social, economical and environmental aspects in construction projects and C)Sustainable construction project management. Further, the research assesses sustainable assessment tools with more emphasis put on sustainable neighborhood development through LEED-ND.

Results: The result finds several key factors for supporting a sustainable construction approach. They are; procurement and management of materials, use of green building practices, use of LCA in decision making and engagement of stakeholders. A viewpoint for the research is an integrated approach to the use of sustainable practices within the processes of implementing particular projects, taking into consideration the environmental, social and economic factors at the various stages of the project. Simultaneously, the LEED-ND has presented itself as an all-encompassing instrument for measuring and directing the sustainable development of neighbourhoods, focusing on both the level of buildings and of whole communities.

Discussion: These are some of the key findings which indicate the interaction between different sustainability issues in construction projects. However, unlike other approaches that focus on the use of technology or even green building, the study brings out the issue of integrated design process, stakeholder engagement, and long term thinking as critical in sustainable development. They also confirm the effectiveness of targeted and case-based approaches because the issues of sustainability and their priorities differ from country to country and from one type of construction project to another.

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Conclusion: The need to understand critical implementation factors for sustainable construction is what has informed this research work and so, this study will add to the existing body of knowledge the world over. It stresses the imperative for constructing higher order change in the construction industry towards the type of sustainability solutions that are based on the idea of utilising a life cycle approach to problem solving. Therefore, understanding the nature and the degree of the elements impacts will help the practitioners, policymakers and the researchers to design measures towards making construction projects sustainable. Future studies should build on stronger linkages of impacts, longer time horizons of assessment, and the identification of new sources of financing sustainable practices

Keywords: Eco efficient construction; Sustainability; Partnership management; Green building; LEED-for-Neighbourhood Development; energy optimization; City planning; Social sustainability; Creativity; Schedule; Cradle to cemetery strategy

1. Introduction

Construction industry is at crossroads today, where it has witnessed unprecedented threats and opportunities for its pursuit for sustainable development. Thus, the infrastructure necessary for the firm's activity in the process of urbanization and development of new constructions became the cause of environmental concerns. Willar et al. (2021) opined that the construct industry use about 40% of the energy and produced about 30% of the greenhouse gases globally. This is a clear implication of the fact that the construction industry has a huge impact on the environment and there is, therefore, the necessity to shift to a more environmentally friendly approach to construction. Sustainable construction therefore involves practices and techniques involving building construction that sought to accomplish five objectives; environmental, social, economic sustainability of built forms throughout their life cycle stage (Fei et al., 2021). As noted by Maqbool and Amaechi (2022), moving to sustainable construction practice is more than a mere function of social equity, but a necessity that will enable the construction industry to sustain competition in the future.

The practice of sustainable construction on the other hand has certain issues that are difficult to address. This piece of work notes that traditional project delivery methods as well as a structure of the construction industry that is fragmented negatively influence the integration of innovative sustainable solutions (Yin et al., 2018). However, the actual cost of implementing green technologies and building materials that are thought of as expensive for the initial stages proves very costly, discouraging other stakeholders from embracing the green building standards of construction even though the long-run returns could be enormous, both economically and environmentally (Hertwich et al., 2019). These challenges are further exacerbated by the fact that there are few benchmarks and indicators or instruments for measuring and comparing sustainability of construction projects and across different contexts and scales.

However, the need for sustainable construction has been on the rise in recent years attributed to the forces such as regulatory requirements, market forces, and the negative impacts of climate change that are being felt more than ever. Sandanayake et al. (2018) point out that governments in various countries are rising their pressure of setting strict environmental policies and rewards to ensure green construction. At the same time, the consumers and investors responded positively towards more transparency and responsibility in construction delivery, as sustainable buildings have the potential to contribute to the long-term building efficiency, occupants' health, and environmental sustainability. These factors have posed significant changes in the industry environment, which are threats or opportunities to the construction industry to transform by implementing new ways of working.

The rationale for this systematic review is to identify the major issues regarding the enablers for the adoption of sustainable construction practices in project delivery and management. Drawing from the available literature and the current best practice, this research seeks to bring together a broad perspective on the important factors that can determine sustainable construction success. Sepasgozar et al. (2020) opined that this change process necessitates application of multipronged strategies that include technological innovations processes as well as culture. This review seeks to examine the following question; how can several sustainable measures be appropriately integrated in each phase of construction project and its construction, operations and at the end of its life?

In addition to this, this research aims at exploring practical cases and trends in sustainable construction as well as strengthening the connection between theoretical concepts and their application. In this very vein, Zhang et al. (2019) highlight the importance of context specificity in sustainability interventions and adaptations by stressing the need to consider such factors as types of projects and context of regions with the aim to come up with effective and efficient strategies of sustainability. With reference to current examples and documented implementations of these concepts along with their strengths and weaknesses from other fields, this review intends to give recommendations to the practitioners, policymakers, and researchers interested in the enhancement of sustainable construction practices. In the end, this multistudied investigation of crucial implementation elements is intended to contribute to the on-going discussion of how the construction sector can become a more active participant in the global sustainability struggles while achieving economic rationality and social responsibility.

1.1. Understanding the Concept of Sustainable Construction Practices in Project Delivery and Management

1.1.1. Evolution of Sustainable Construction Concepts

Sustainable construction modeling has undergone major changes over the last few decades which has mirrored certain trends in environmental sensitivity, and sustainability frameworks. Willar et al. (2021) note that concerns of sustainable construction can be dated back to the energy crisis in the 1970s, which born the interest in energy efficient construction. Yet, only in the late eighties and early nineties could one define a more holistic concept of sustainable construction. The ideas of sustainable development was brought in to the lime light from the publication of the Brundtland report in 1987 where sustainable development was defined as development that can fully satisfy the needs of the present without in any way diminishing the capacity of future generations to meet their own needs (Fei et al., 2021). From this definition the process was initiated for implementing sustainability to the construction industry.

At that time, one of the dominant trends of sustainable construction was dictated by environmental concerns, that is focused on energy efficiency, generation of minimal waste and utilization of environmentally friendly building materials. Yin et al. (2018) identified that there emerged different kind of green building rating tools such as; the Leadership in Energy and Environmental Design in the United States and Building Research Establishment Environmental Assessment Method in United Kingdom in this period. These systems were instrumental in creating, encouraging and disseminating best practice and sustainable construction. Nevertheless, as stated by Maqbool and Amaechi (2022), such an approach failed to provide sufficient emphasis on sustainability's social and economic aspects.

Sustainable construction has moved over the last decade from a sole focus on environmental dimension of construction and development to the triple bottom line. According to Hertwich et al. (2019), this shift has brought into the foreground matters like occupant comfort, and welfare, and social sustainability, lifecycle costing. In addition, the opportunities of using digital technologies and data analyses in identifying and enhancing the sustainability impact of buildings and constructed facility projects at the life-cycle level have been offered and discussed (Sandanayake et al., 2018).

1.1.2. Regulatory Landscape and Policy Frameworks

There has been an increased change in the regulatory framework of sustainable construction in the last few years as the world becomes more sensitive to issues to do with climate change and environmental depletion. As pointed out by Sepasgozar et al. (2020), governments from all over the world have put into use various policy measures to enhance sustainable building such as; Compulsory local building codes, Energy performance regulations and Green procurement. For instance, the EPBD applied in the European Union obliges that nearly all the new constructed buildings should be nearly zero-energy by 2021, which made Europe's construction sector to set aggressive energy efficient targets (Zhang et al., 2019). Besides the regulatory approaches, the financial drives and the market approaches that encourage sustainable construction activities have been adopted widely among the countries. According to Willar et al. (2021), the range of incentives include, tax credits for investment in green buildings, fast-track permit for sustainable structures, and special financing rate for energy efficient structures. Moreover, there are carbon pricing mechanisms that have developed into internalization of environmental costs of construction activity and emissions trading schemes that encourage low carbon solutions [Fei et al., 2021].

International organization and certification has also depicted its significant influence in the forms of regulation for sustainable construction as well. Yin et al. (2018) noted that the international standards, including ISO 14001 for environmental management systems and ISO 50001 for energy management are useful for an appropriate approach to sustainability in construction. However, more flexibility is offered by the voluntary green building certification systems that are in use across the world such LEED and BREEAM that have become a requirement by being adopted in the local building codes and regulations as pointed out by Maqbool and Amaechi in 2022. However, the regulation of sustainable construction is still not well coordinated and there is an increased variation in the formulation of policies and regulation across the different parts of the world. According to Hertwich et al. (2019), there is a need to ensure that the existing standards and policies are well aligned at the international level with a view of making the environment even for everyone hence promoting sustainable construction at the international level. Besides, the people are now equally realizing the need for enhanced integrated policies that take care of the entangled relationships between buildings, constructions, and the urban planning processes in order to attain sustainable built environments and systems (Sandanayake et al., 2018).

1.1.3. Technological Innovations in Sustainable Construction

High technology has acted as the enabler and driver of sustainable constructions mainly due to the following reasons. Sepasgozar et al., (2020) has pointed out that the use of technologies such as BIM, IoT and AI in designing, constructing and operating sustainable building has brought a new direction. BIM, in particular, is now seen as an approach that caters for the improved efficiency in building performance, enhances integrated design approach and enables conversion of building design information between stakeholders (Zhang et al., 2019).

With respect to sustainable performance there has been much improvement in more advanced material and construction technologies in the recent past. These include self-healing concrete, transparent solar cells, and 3D-printed building parts reduced on a typical level, the use of the possibility of resources and energy efficiency will be minimized and waste. Additionally, circular economy principles in construction considered and has introduced during the last few years the utilization of used and reusable materials, construction modularation, and new deconstruction methods in constructions.

Energy-efficient technologies have also rapidly developed, concerning building envelope systems, heating, ventilation and air conditioning (HVAC) devices and lighting. Yin et al. (2018) agree with the observation noting that building integrated photovoltaic systems and geothermal heat pump systems in the provision of power have been incorporated widely in sustainable buildings. Furthermore, the utilization of big data and environmental control with the application of information technology also has become popular in smart building to enhance energy utilization efficiency and indoor environment quality (Maqbool and Amaechi, 2022).

New ways of off-site construction with an increased application of prefabrication methods has also played a role in advancing construction sustainability. According to Hertwich et al. (2019) these types of approaches have the abilities of minimizing the material wasted, increasing quality assurance, and decreasing construction time all of which would sum up for improving the sustainability performance. However, the application of the robotic technology and the automation in construction processes is likely to enhance future efficiency of resource utilization and diminish the negative effects of constructions on the physical environment (Sandanayake et al., 2018).

1.1.4. Stakeholder Engagement and Collaboration in Sustainable Construction

According to the findings of the research, stakeholder management is a critical success factor to the construction of sustainable buildings throughout the project life cycle. This is in line with the observation made by Sepasgozar et al. (2020) that the application of sustainable construction involves the integration of many sub-disciplinary tasks and therefore calls for the adoption of more integrated and cross-disciplinary means of incorporating sustainable construction into construction projects. This shift requires participation of architects, engineers, contractors, suppliers, clients, end-users and local communities in the choice making at the inception stage of project development (Zhang et al., 2019). The concept of Integrated design that has developed recently has be named to be the major process at facilitating business collaboration and achieving sustainable results in the construction business. According to Willar et al. (2021), these processes allow integrating the different expertise to define various cooperation avenues on the optimisation of systems performance and the management of possible clashes during the initial stage of each project.

In addition, technology, be it in the form of a cloud-based application for project management, or Virtual Design and Construction tools, supports the work of project teams with more effective means of sharing information (Fei et al., 2021). Another factor that has also received attention is the community engagement in construction especially in large construction projects and in urban development. Yin et al. (2018) entitled to it that local stakeholders must be involved in the process of planning and designing to foster projects that meet the needs of the people and are culturally sensitive and enhances the social sustainability. On the same note, the involvement of stakeholder participation such as the participatory design approaches and the community-based projects to implement sustainable built environments have been effective regarding ownership in the long-term stewardship of sustainable built environments (Maqbool and Amaechi, 2022). Management of supplies in sustainable construction has received increasing attention, and concentrated effort is given on the suppliers and sub- contractors of the constructions. Hertwich et al. (2019) believe that the non-commercial models like green supply chain management and life cycle assessment of the materials are important for overcoming the environmental footprint of construction projects.

Aim and Objectives

The general research purpose of this study is consequently to provide a critical review and analysis of the essential factors that undergird the effective integration of sustainable construction practices in project delivery and management. Therefore, with the aim to contribute to the existing knowledge on the ways in which the construction industry may move towards more sustainable and resilient, the findings of this study focus on the current tendencies, risks, and solutions in the field.

To achieve this aim, the following specific objectives have been established: To achieve this aim, the following specific objectives have been established:

- For the purpose of assessing the shifts in construction industry's involvement in sustainable development process and recognizing the key environmental, social and economical consequences correlated with the construction processes.
- In order to assess the effectiveness of approaches and methods aimed at improving the social, economic, and environmental sustainability of construction projects at the life-cycle level.
- To evaluate performance of a number of sustainability measures and tools as well as selected focal measurement system, the LEED-ND.
- In an effort to pinpoint sustainability considering principles and practices that may be applied to construction project management and discuss their application in the construction project management, these guidelines were designed.
- Thus, to evaluate the possibilities of using new technologies, materials and construction approaches for enhancing sustainable construction and improving construction project outcomes.
- In order to delineate the influence of stakeholder management and cooperation and exchange of knowledge as the means to increase the usage of sustainable construction practices within the construction industry.
- To explore the problems that hinder a sustainable construction industry and to consider possible methods and measures that may aid in overcoming such issues with the purpose of providing policy recommendations.
- In order to factor out the applicability of such elements, the author decided to examine examples of the effective implementation of sustainable construction practices for the purpose of coming up with the lessons learnt as to the industry stakeholders and policy-makers.

Through meeting of these objectives, this study intends to extend knowledge on sustainable construction and offer practical recommendations to various stakeholders including construction companies, governments and academician and scholars in the field of sustainable construction.

2. Review of The Literature

2.1. The Role of the Construction Industry in Sustainable Development

The building construction industry is central to the global sustainable development since the business is associated with environmental issues and at the same time has the potential of offering solutions to these problems. Fei et al, (2021) pointed out that the sector currently consumes 40 % of the world's energy and is responsible for30% of emissions, and 50% of raw material use. These effects show that there is an absolute necessity to shift the paradigm in construction practices. Nevertheless, the industry also holds tremendous potential of adding positive value in the global effort towards achieving sustainable development goals. According to Willar et al. (2021), the incorporation of sustainable construction activities can impact more than one of the UN's SDGs, the actual implementation impacting (SDG): 11 which is; Sustainable Cities and Communities, (SDG) 12 which is; Responsible Consumption and Production as well as (SDG) 13 which is Climate action. In this context, green building can considerably decrease a construction sector's adverse impact on the environment through sustainable design, energy-efficient products, and new construction materials that positively affect the comfort and welfare of occupants and neighbors.

The economic effects of sustainability in construction practices are equally demanding. Though the cost of green building technologies, sustainable materials and other environment-friendly technologies may be slightly higher initially, many researches have established that value comes with cost in the long-run. Hertwich et al., (2019) in his review provided a view that green buildings constitute of about 20 to 30 percent of the operational costs than the conventional constructions mostly generated from energy and water conservation. In addition, sustainable construction promotes economic regeneration through development of new market agendas for green products and services, innovations and employment in the green industries. The following table provides an understanding about how sustainable construction practices are beneficial from an economic point of view irrespective of type of projects.

Table 1 Economic Benefit of Sustainable Construction Practices

Project Type	Energy Savings (%)	Water Savings (%)	Operational Cost Reduction (%)	ROI Improvement (%)
Commercial	25-35	30-50	20-30	15-20
Residential	20-30	25-40	15-25	10-15
Industrial	30-40	35-55	25-35	20-25
Educational	22-32	28-45	18-28	12-18
Healthcare	28-38	32-52	22-32	18-23
Retail	23-33	27-42	17-27	11-16
Hospitality	26-36	31-51	21-31	16-21

Source: Adapted from Hertwich et al. (2019) and Fei et al. (2021)

*T*he social aspects of construction and construction as social practices are becoming the essential part of the overall sustainability management. In their works, Maqbool and Amaechi (2022) stressed on the viewpoint that sustainable building performance can greatly boost the level of occupant health, comfort, and productivity. For instance, enhanced indoor environment, natural light, and biophilia components are associated with low rates of truancy, better brain performance, and health for inhabitants of homes and, employees in workplaces. In addition, while the projects of sustainable constructions have the capacity to meet the benefits of the stakeholders, they are usually developed with communal involvements and social justice issues in mind, thus creating socially balanced and strong cities. Yin et al. (2018) also underlines the necessity of understanding cultural values, history and tradition of the local people, and of wisely protecting and designing cultural heritages, as well as designing public spaces to ensure the successful creation of comfortable, friendly, and safe communal environment. With respect to these social factors, sustainable construction helps in creating better, just and sustainable urban environments.

However, there are many challenges in the implementation of construction project sustainability measures which are obvious. According to Sandanayake et al. (2018) there are major challenges such as: higher initial cost, low awareness and knowledge, industry segmentations and insufficient and ineffective policies. To mitigate them, several parties such as governments, industry associations, educational institutions and individual firms needs to come into coalition. According to Zhang et al. (2019) the realization of sustainable construction policies require that there be culture change where sustainable construction practices are adopted to focus more on creating sustainable value than on cost reduction. This shift requires greater coordination between project participants, end-to-end integration of sustainable factors, and ongoing, innovation of the materials, technologies, and processes. The construction industry is a major player in sustainable development and is more relevant over the years and will continue to be relevant and hence more research effort, policy support, and commitment are required.

2.2. Strategies for Enhancing Social, Economic, and Environmental Sustainability in Construction

It is practically impossible to improve sustainability of construction projects through the lens of a single factor of sustainability alone, but it can be achieved by a combination of environmental, social, and economical factors taken together. Sepasgozar et al., (2020) have provided a conceptual model that focuses on the interdependency of these three components that shape sustainable construction. Some of the best practices are centred on environmentalism and they include energy efficiency optimization, waste minimization and reduction in carbon footprints across the various phases of a project. Referring to Willar et al. (2021), the authors stressed on the urgent need to approach circular economy in construction context especially on the use of materials that are reusable, recyclable, and renewable. It not only minimises the effect on the environment, but also enables the generation of more economic value from resources and waste materials. In addition, the application of reference solutions in construction can improve the ecological and use tolerance of the territories, as well as their resistance to the harms of climate change: enhance the density of bio-diversity, condition the air, and reduce the risks of the effect known as the 'Heat Island' for the benefit of both ecological and social justice.

Economic sustainability in construction can therefore be described as being a function of value, time and risk. In line with this thinking, Fei et al. (2021) suggest that improved forms of managing buildings' cost incorporate more of the lifecycle costing strategies and integrated project delivery techniques. Thanks to the introduction of the concept of total life cycle cost of the project, the stakeholders will be in a better position of making right decisions that would incorporate aspects such as cost of construction, cost of operation, maintenance as well as the final demolition of the project. Furthermore, market value of sustainable technologies such as energy-efficient lighting and sound, and sustainable building materials can lead to substantial expenditure reductions in operating costs throughout the life cycle of the building. Comparative analysis of the lifecycle costs between conventional buildings and sustainable building projects is presented in table 2 below categorized as follows:

Table 2 Lifecycle Cost Comparison of Conventional vs. Sustainable Building Projects ($/sq ft)

Cost Category	Conventional	Sustainable	Difference (%)
Initial Construction	215.50	225.00	+4.41%
Energy	68.80	51.60	-25.00%
Water	12.40	9.30	-25.00%
Operations & Maintenance	135.60	129.00	-4.87%
Replacement	48.90	44.00	-10.02%
Residual Value	-37.20	-41.00	+10.22%
Total Lifecycle Cost	444.00	417.90	-5.88%

Source: Adapted from Sepasgozar et al. (2020) and Willar et al. (2021)

With regard to construction, what may be classified under social sustainability are needs of the occupants, interaction with the community and cultural aspects. Yin et al. (2018) set on the issue of applying the principles of universal design and accessibility features when designing the built environment for all users. Furthermore some research indicates that involving communities in the planning and designing phases can also help to overcome barriers to acceptance by communities of the development process and that engineering projects can reflect culture and vision of the people living in the area where these structures are to be developed. For instance, Maqbool and Amaechi (2022) argue that sustainable construction was relevant in delivery of affordable housing, inclusive and equal access to quality infrastructure and other needs of the society. Social impact assessment as well as CBAs can help construction projects to make a better positive contribution to social inclusion and local economic regeneration.

They have found that the application of many of these sustainability initiatives entails the use of innovative methods of project delivery and relations with key clientele. Integrated processes of designing are also supported by Hertwich et al. (2019) where analysis of knowledge suggests that employers ought to include various types of niche experts from the beginning of the project design stage. It allows for the discovery of synergies between different sustainability goals and subsequently for more integrated decision-making. Further, application of the integrating techniques of integrated computational environment like Building Information Modeling (BIM) as well as energy performance simulation software can assist in the enhancement of the overall sustainability performance of buildings. Sandanayake et al. (2018) also stress that post occupancy evaluation regarding the sustainable performance of buildings is crucial, at each stage of the construction life cycle to determine the need for the incremental improvement of the sustainability performance. Through the implementation of such strategies in addition, to use of particular tools the construction industry can achieve the objective of sustainable and resilience built environment for social, economic as well as environmental stewardship.

2.3. Sustainability Assessment Tools and Frameworks

Sustainability assessment tools along with frameworks are very useful to help and support to carry out the sustainable construction practices. These tools give benchmark of environmental, social and economical performances at different phases of construction undertaking life cycle. Zhang et al. (2019) further explained that the availability of the sustainability assessment tools in the recent past have both made it easier and difficult for the construction industry to embrace sustainable practices. Despite the usefulness of these tools and the help they provide with guidance and certification, there is a large number of frameworks available, and it may be difficult to compare the/project performance in a particular field with other contexts for long. According to Willar et al. (2021), there are numerous well-known assessment tools, namely LEED, BREEAM, and Green Star for which the focus areas and scoring system differ.

Of these assessment frameworks, LEED-ND has received much attention due to its holistic assessment of sustainable neighbourhood development. Fei et al. (2021) note that LEED-ND goes further than the building efficiency and focuses on such problems of neighborhood development as connectivity and community health. The framework comprises three main categories: SLL which includes Intelligent Spaces and Connections, NPD which include Neighbourhood Form and Layout, and GIB which refers to Green Structures and Construction. The Table 3 provides the brief summary of LEED-ND credit category and their distribution of weight, showing that the LEED-ND is flexible in equalizing neighborhood-scale sustainability assessment.

Table 3 LEED-ND Credit Categories and Weightings

Credit Category	Available Points	Percentage of Total
Smart Location and Linkage (SLL)	28	25.45%
Neighborhood Pattern & Design (NPD)	41	37.27%
Green Infrastructure & Buildings (GIB)	31	28.18%
Innovation and Design Process	6	5.45%
Regional Priority Credits	4	3.64%
Total	110	100%

Source: Adapted from U.S. Green Building Council (2018)

Many current research and scholarly studies have focused on the extent to which sustainability assessment tools are useful in enhancing the industry performance. Yin et al. (2018) stated that although the effectiveness of these frameworks in increasing awareness and establishing new benchmarks for construction sustainabilities is undisputable, the positive change in building performances and future sustainability improvements is still inargitative. Critics have pinpointed several areas of concern including; potential for green washing and the fact that the emphasis is on passing the certification test rather than on achieving the best performing efficiency on real life tests. To this effect, Maqbool and Amaechi (2022) call for more functional and content-based assessment frameworks that are periodically assessed and audited throughout a building's life cycle. This approach would improve the possibilities of more accurate assessment of sustainability results and continuous enhancement of the building operations.

Nevertheless, sustainability assessment tools remain dynamic on the progressive prolongation and establishment with certain alterations according to new demands of the industry and new sustainable issues. Hertwich et al. (2019) reveal that there has been a growing trend in including life cycle assessment (LCA) methodologies into the sustainability rating systems which facilitates the sound assessment of the environmental footprint through the lifecycle of the building. Secondly, there is increasing interest in Social Sustainability Indicators including health of occupants; Engagement of people; and Social Justice. In the same vein, Sandanayake et al. (2018) state that digital technologies and data analysis offer a chance to increase the effectiveness and credibility of sustainability assessments as well as to develop methods that can monitor performances and criteria in real-time as well as provide more detailed evaluations of sustainability outputs. With these tools in their present state of evolution as with other tools in similar developmental stages, they are expected to play some more pronounced roles such as these in engineering sustainable construction practices and UPPING their usefulness in policy formulation and influencing choices within the built environment sector.

2.4. Principles of Sustainable Construction Project Management

p1: Management of sustainable construction projects calls for D a parathinking and perspective shift from the conventional business and construction project delivery model. According to Sepasgozar et al. (2020), the application of sustainability principles should incorporate the project management activities to address the shift's courses in the construction industry. Out of the principles of sustainable construction project management, the following considerations are crucial; The life cycle thinking, stakeholder management, risk management, and quality improvement. Willar et al. (2021) also speak about the necessity of integrating sustainability aspects at the preliminary stage of works, in the framework of project development, as this ensures better identification of potential reviews of design proposals and optimal distribution of resources. This proactive approach can help the project teams to look for other opportunities/sacrifices that can be made between different sustainability goals so that there is consistent and sound result for the projects to be done.

Stakeholders' management is one of the primary aspects of sustainable construction project management where many decisions have to be transparent and made cooperatively with stakeholders. In their paper Fei et al., (2021) underline the importance of setting up sustainability objectives and metrics in cooperation with clients, designers, contractors, and users. This way of employee engagement is ideal as it serves to maintain consistence between what is expected to be achieved in a project and the expectations of the stakeholders besides promoting responsibility towards sustainability initiatives. Also, the involvement of local communities and regulatory structures in the project development stage could foresee social and other issues that are likely to arise when carrying out the project hence avoiding lapses that may cause a conflict and eventually delay the project. Based on the engagement level of stakeholders the influence of stakeholder engagement on project performance indicators in sustainable construction projects is further outlined in table 4 below.

Table 4 Impact of Stakeholder Engagement on Project Performance Indicators

Performance Indicator	Low Engagement	Moderate Engagement	High Engagement
Cost Overruns (%)	15.3	8.7	4.2
Schedule Delays (%)	18.6	10.2	5.8
Change Orders (per project)	7.4	4.9	2.7
Client Satisfaction (1-10)	6.2	7.8	9.1
Sustainability Performance (1-10)	5.8	7.5	8.9
Innovation Adoption Rate (%)	12.5	23.6	37.2
Community Acceptance (1-10)	5.9	7.3	8.7

Source: Adapted from Sepasgozar et al. (2020) and Fei et al. (2021)

Sustainable construction projects entail assessment of risks that may be seen with the objective of achieving the laid down goals of the project. As a highly comprehensive framework, Yin et al. 's (2018) risk assessment model encompasses both the conventional project risks and the sustainable-related risks which include regulatory compliance, market demand for green buildings and long-term performance risks. This paper therefore recommends that sustainability in construction projects can benefit from adoption of systematic risk management by project managers to increase on the robustness and flexibility need in sustainable construction projects. In that regard, according to Maqbool and Amaechi (2022), it is crucial to consider the use of sensitivity and scenario analysis to determine the sustainability strategies' readiness for future conditions, so that it would be possible to make more effective decisions and allocate resources.

Sustainability and learning are the key concepts within environmental management of construction projects that supports the concept of innovation and improvement. According to Hertwich et al. (2019), the relevant monitoring and evaluation frameworks and practices, which capture sustainability outcomes and impacts consistently throughout a project's life cycle and post-project, should be promoted, enhanced, and supported. Energy audited information, water consumption, waste generation, and occupants' feedback are also collected so that project team could identify that where changes could be incorporated fro better results in the future projects. According to Sandanayake et al. (2018), there is a possibility of implementing post occupancy evaluations and lifecycle assessments to assess the effectiveness of sustainable design and several solutions on efficiency and actively engage on framing the industry benchmarks. In addition, the creation of knowledge sharing and lessons learned mechanisms within and between organization can help to fast track the process toward the adoption of success sustainably practices in construction industry and ultimately initiate continual improvement.

2.5. Innovative Technologies and Materials in Sustainable Construction

The advancement in the technology and material science therefore presents new opportunities for designing for sustainability in construction. According to Zhang et al. (2019), emerging technologies and innovative materials are essential in responding to the negative impacts of traditional construction methods since they also bring about enhanced building performance and comfort of occupants. One of the most revolutionary technologies adopted in many construction projects over the recent past is BIM in sustainable construction. BIM enhances the capability of providing better simulation and optimization of the building performance, further improves the chance of integrating the design process and minimizes the opportunities of having mistakes or wastage during the construction process. According to Willar et al. (<YEAR>), the cumulative cost savings due to the implementation of BIM in project construction ranges at around 20-30% while the possible increase in energy efficiency ranges at around 15-25% because of the improved co-ordination and decision making that comes with BIM implementation.

3. Materials and Methods

This research used the literature review approach in developing and analyzing the available knowledge on sustainable construction practices. Leveraging critical success factors of sustainable construction practices in project delivery and management : The research was also based on understanding how the industry can work effectively towards being sustainable economically, environmentally and socially throughout the entire lifecycle of a construction project.

The initial research strategy involved the use of academic database search information from peer reviewed journals, industry reports, and sustainable construction assessment tools. To select the sources, the use of major databases, including Scopus, Web of Science, and Google Scholar as well as articles published in the last 10 years were considered. Keywords used in the study were 'sustainable construction,. ' 'green building,''project management,' 'environmental impact,' and 'social sustainability. ' Full text articles of more than 500 articles that were obtained from the search were screened based on their abstracts and retained keywords.

To complement the TH and get more data and feelings from other industry representatives and specialists, the investigators created an analogous online questionnaire using Google Forms. This questionnaire contained close-ended as well as the open-ended questions with the aim of obtaining the data on the current use of sustainable construction, struggles with its implementation and the perceived CSFs. The survey link was posted on LinkedIn, Facebook, and some of the construction professionals' groups and forums where the members have worked on sustainable construction projects.

In addition to the literature review and questionnaire survey, interviews were held with representatives of construction organizations to enrich the resource. Respondents were architects, project managers, sustainability consultants and policymakers who were purposively chosen and sampled based on their participation in sustainable construction projects. The interviews were taken virtually over video conferencing platforms because of geographical restrictions and recurring health risks. Most of the interviews ranged between 60-90 minutes with the Respondents and the interviewer using structured questions and prompts developed from the literature review guiding the research study.

The research also utilized a literature review of current sustainability assessment indices and frameworks as well as the Leadership in Energy and Environmental Design for Neighborhood Development (LEED-ND) index. This entailed an objective analysis of the LEED-ND standards, point systems and performance of projects that have been certified. The research team also assessed relevance to sustainability and impact of the introduced tools on sustainable constructions.

it was important to gain a broad understanding of the topic under study the data included policies, codes of practice, standards and guidelines on sustainability in construction. This involved works available from different forums including the United Nations, the World Green Building Council and national bodies of regulation. These documents proved to be exceptionally helpful in giving context to the juridical regulation situation and the trends concerning environmentally responsible construction across the world.

Literature data review, surveys, interviews and document analysis collected data was systematically coded and categorized using qualitative data analysis tool. Such a process makes it possible to sort out the given key issues, modes, and interconnections between various aspects of sustainability construction activities. The members of the research team used the thematic synthesis method to analyze the data and establish the coherent framework to examine the critical implementation factors.

In order to increase the validity and reliability of the research, study used triangulation of data sources and method. This consisted of comparing the findings from the review of literature with what the respondents and the interviewees had to say which provided additional layers of understanding to the information that was being analyzed. Moreover, preliminary results were discussed with the group of experts in the field to get the feedback of the peers and improve the analysis and conclusions made.

All ethical issues were well addressed during the process of conducting research. Interview consent forms were signed by all survey respondents and the interview participants and their identity was not disclosed in reporting the findings. The research proposal was only reviewed and approved by the institutional ethics committee before data were collected.

The approach used in this study was chosen in a way which would seek to incorporate the necessary detail and context to identify critical success factors in sustainable construction. Thus, the research aimed at synthesizing literature review with industry professionals' and policymakers' perspectives on sustainable construction project delivery and management.

4. Discussion and Conclusion

4.1. Critical Factors for Implementing Sustainable Construction Practices

An understanding of the sustainable construction practices will show the following stabilization features that affect the process of delivery and management of sustainability phases: Another category of measures highlights that sustainability aspects are integrated from the conceptualization of the projects and their design phases. This corresponds with the LEED v4 for Neighborhood Development Plan Checklist where smart location and linkage is a basic category. Smart location gets the most significant point allocation from the checklist where about 28 points are assigned under this category which include aspects like Endangered species and Ecological Communities; Wetland and Water Body Conservation. Such elements emphasize the importance of a systems approach while evaluating potential sites that will be developed to support the urban connection, concurrently, without harming the environment (Willar et al., 2021).

LEED v4 for Neighborhood Development Plan
Project Checklist

Project Name:
Date:

Yes	?	No			
0	0	0		**Smart Location & Linkage**	**28**
Y			Prereq	Smart Location	Required
Y			Prereq	Imperiled Species and Ecological Communities	Required
Y			Prereq	Wetland and Water Body Conservation	Required
Y			Prereq	Agricultural Land Conservation	Required
Y			Prereq	Floodplain Avoidance	Required
			Credit	Preferred Locations	10
			Credit	Brownfield Remediation	2
			Credit	Access to Quality Transit	7
			Credit	Bicycle Facilities	2
			Credit	Housing and Jobs Proximity	3
			Credit	Steep Slope Protection	1
			Credit	Site Design for Habitat or Wetland and Water Body Conservation	1
			Credit	Restoration of Habitat or Wetlands and Water Bodies	1
			Credit	Long-Term Conservation Management of Habitat or Wetlands and Water Bodies	1
0	0	0		**Neighborhood Pattern & Design**	**41**
Y			Prereq	Walkable Streets	Required
Y			Prereq	Compact Development	Required
Y			Prereq	Connected and Open Community	Required
			Credit	Walkable Streets	9
			Credit	Compact Development	6
			Credit	Mixed-Use Neighborhoods	4
			Credit	Housing Types and Affordability	7
			Credit	Reduced Parking Footprint	1
			Credit	Connected and Open Community	2
			Credit	Transit Facilities	1
			Credit	Transportation Demand Management	2
			Credit	Access to Civic & Public Space	1
			Credit	Access to Recreation Facilities	1
			Credit	Visitability and Universal Design	1
			Credit	Community Outreach and Involvement	2
			Credit	Local Food Production	1
			Credit	Tree-Lined and Shaded Streetscapes	2
			Credit	Neighborhood Schools	1

Yes	?	No			
0	0	0		**Green Infrastructure & Buildings**	**31**
Y			Prereq	Certified Green Building	Required
Y			Prereq	Minimum Building Energy Performance	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Construction Activity Pollution Prevention	Required
			Credit	Certified Green Buildings	5
			Credit	Optimize Building Energy Performance	2
			Credit	Indoor Water Use Reduction	1
			Credit	Outdoor Water Use Reduction	2
			Credit	Building Reuse	1
			Credit	Historic Resource Preservation and Adaptive Reuse	2
			Credit	Minimized Site Disturbance	1
			Credit	Rainwater Management	4
			Credit	Heat Island Reduction	1
			Credit	Solar Orientation	1
			Credit	Renewable Energy Production	3
			Credit	District Heating and Cooling	2
			Credit	Infrastructure Energy Efficiency	1
			Credit	Wastewater Management	2
			Credit	Recycled and Reused Infrastructure	1
			Credit	Solid Waste Management	1
			Credit	Light Pollution Reduction	1
0	0	0		**Innovation & Design Process**	**6**
			Credit	Innovation	5
			Credit	LEED® Accredited Professional	1
0	0	0		**Regional Priority Credits**	**4**
			Credit	Regional Priority Credit: Region Defined	1
			Credit	Regional Priority Credit: Region Defined	1
			Credit	Regional Priority Credit: Region Defined	1
			Credit	Regional Priority Credit: Region Defined	1
0	0	0		**PROJECT TOTALS (Certification estimates)**	**110**

Certified: 40-49 points, **Silver:** 50-59 points, **Gold:** 60-79 points, **Platinum:** 80+ points

Figure 1 LEED checklist for neighborhood development plan

One more vital factor derived from the study is the importance of the neighborhoods' configuration and layout, which is allocated the biggest number of points in LEED-ND checklist: 41. This category includes such important components as accessible street, compactness, and mixed-type neighborhoods. The increasing relevance of one's society and the relations between them and the built environment is also seen in the fact that these criterias are significantly weighted. For example, the questioned criteria such as housing types and housing affordability (7 points) and access to civil and public areas (1 point) stress on the provision of diverse housings for the populace of all classes. This is in agreement with the argument made by Maqbool and Amaechi (2022) that sustainable construction has a social equity dimension in that it is used in enhancing social interaction in the society.

4.2. Strategies for Enhancing Sustainability Performance in Construction Projects

It is important to note that from the identified research there are several strategies that may be used in improving sustainability performance in construction projects. One of the approaches that stood out is the use of Green Infrastructure and Building which is given 31 points in LEED-ND Checklist. This category includes sustainability measures such as green buildings which are certified, minimum building energy and indoor water use. The incorporation of these criteria re-emphasizes the consideration of both building specificity as well as the role that buildings play in neighborhood scale sustainability. For instance, the focus of two points to the optimum building energy performance and three points to the renewable energy categorization reveals the construction industry's awareness of the combat against climate change through improved efficiency and application of clean sources of energy as acknowledged by Hertwich et al. (2019).

Furthermore, the findings showed that innovation and regional adaption are critical to enhancing sustainable construction processes. The LEED-ND provides 6 points for innovation and design process and this encourages the projects to adopt additional measures in the field of sustainability. This is in line with the assertions made by Sepasgozar et al. (2020) stress on the need to ensure that sustainable construction is continuously improved and that knowledge regarding the practice is shared. Also, the checklist adopted by the LEED has the four credits of the regional priority with 4 points to consider the fact that different regions might require different sustainable approaches to environmental, social, and economic problems. This approach aligns with Zhang et al. (2019) suggestions whereby they call for the foucssing on how sustainability assessment tools could be fit-for-purpose in different regions as a way of increasing their applicability.

The analysis also concluded on Integrated Project Delivery as being key to enhancing sustainability directions. Similar to the findings of one of the previous studies which noted that LEED-ND's point distribution reveals much about the process since it provides goals that require integration of diverse expertise from the onset and emphasizes planning and design, thus supporting the conclusion that the idea of implementing collaborative approaches from the conceptual stage is critical. In this regard, this finding supports the assertion made by Fei et al. (2021) that integrated design processes help in identifying interaction between different sustainability requirements and promote a more systems approach to decision making. Also, the research focused on the aspects of sustainable construction which are closely connected with the concept of lifecycle thinking, such as building reuse (1 point) which refers to the LEED-ND checklist as well as infrastructure energy efficiency (1 point). This approach would make the project teams to think of the environmental and economic effects of the designs taking into consideration the circular economy in construction as recommended by Sandanayake et al. (2018).

4.3. Integration of Sustainability Criteria in Project Planning and Execution

The LEED v4 for Neighborhood Development Built Project Checklist shows a broad structure that contains a set of sustainability criteria that may be applied throughout the planning and construction phases of a built project. This integration is important to achieve a transformed goal of sustainability since it reflects on the environmental, social and economic aspects. The checklist elements are supported by Smart Location & Linkage, Neighborhood Pattern & Design, Green Infrastructure & Buildings, Innovation & Design Process, and Regional Priority Credits that provide a clear and easily understandable structure that referring to sustainable development principles correlate not only in the sphere of building performance but also at the larger neighborhood scale.

Perhaps the most important point discussed within the course of the checklist is the account of smart location and ecological protection during the conceptual stage of the project. Of the available 28 points, Smart Location & Linkage category underlies need for site selection and development approaches that have minimal adverse environmental effects on their surroundings while linking them to rest of urban fabric. Smart Location, Imperiled Species and Ecological Communities Conservation, and Wetland and Water Body Conservation prerequisites stress the requirement for adequate investigation of the Site Environmental Characteristics as well as protection measures prior to commencement of a project. This corresponds with the study of Willar et al. (2021), whereby they and other researchers have noted that early consideration of sustainability intervention within the project cycle is of paramount importance in similar projects if environmental impact is to be realised.

The largest point-scoring category of Neighborhood Pattern & Design (41 points) clearly shows the awareness of the relationship between built environment and social sustainability. Some of the principles which are characterized by Walkable Streets, Compact Development, and Mixed-Use Neighborhoods and so on are oriented at the effective formation of the comfortable, easily accessible, and multi-functional environment. The Housing Types and Affordability credit (7 points) and Access to Civic and Public Spaces credit (1 point) reflect social responsibility and the well being of communities, in sustainable construction work. Maqbool and Amaechi (2022) also noted that the planning of a project should include a social impact of the development to create a cohesive neighbourhood economic base.

The Green Infrastructure & Buildings, which offers 31 points, helps to establish the practices to address the sustainability of the entire building systems and infrastructures. It can be seen that Certified Green Buildings, Minimum Building Energy Performance and Indoor Water Use Reduction follows the parsimonious approach where resource efficiency and environmental performance is being addressed. Recognition of Credits for Renewable Energy Production (3 points) and Infrastructure Energy Efficiency (1 point) is directed at innovative technologies and systems thinking measures aimed at low environment impacts of development initiatives. This concurs with Hertwich et al., (2019) who propose that efficiency measures in the use of materials and integration of renewables in construction practices have far reaching possibilities of cutting the embodied emissions in buildings and structures. Even the credits for Historic Resource Preservation and Adaptive Reuse (2 points) shows the commitment to protection of cultural and historical heritage in terms of efficient use of existing buildings as well as awareness of necessity of preserving Europe's environment and history while invigorating stagnant urban centers.

LEED v4 for Neighborhood Development Built Project
Project Checklist

Project Name:
Date:

Yes	?	No			
0	0	0		**Smart Location & Linkage**	**28**
Y			Prereq	Smart Location	Required
Y			Prereq	Imperiled Species and Ecological Communities	Required
Y			Prereq	WetlandS and Water Body Conservation	Required
Y			Prereq	Agricultural Land Conservation	Required
Y			Prereq	Floodplain Avoidance	Required
			Credit	Preferred Locations	10
			Credit	Brownfield Remediation	2
			Credit	Access to Quality Transit	7
			Credit	Bicycle Facilities	2
			Credit	Housing and Jobs Proximity	3
			Credit	Steep Slope Protection	1
			Credit	Site Design for Habitat or Wetland and Water Body Conservatior	1
			Credit	Restoration of Habitat or Wetlands and Water Bodies	1
			Credit	Long-Term Conservation Management of Habitat or Wetlands and Water Bodies	1
0	0	0		**Neighborhood Pattern & Design**	**41**
Y			Prereq	Walkable Streets	Required
Y			Prereq	Compact Development	Required
Y			Prereq	Connected and Open Community	Required
			Credit	Walkable Streets	9
			Credit	Compact Development	6
			Credit	Mixed-Use Neighborhoods	4
			Credit	Housing Types and Affordability	7
			Credit	Reduced Parking Footprint	1
			Credit	Connected and Open Community	2
			Credit	Transit Facilities	1
			Credit	Transportation Demand Management	2
			Credit	Access to Civic & Public Space	1
			Credit	Access to Recreation Facilities	1
			Credit	Visitability and Universal Design	1
			Credit	Community Outreach and Involvement	2
			Credit	Local Food Production	1
			Credit	Tree-Lined and Shaded Streetscapes	2
			Credit	Neighborhood Schools	1

Yes	?	No			
0	0	0		**Green Infrastructure & Buildings**	**31**
Y			Prereq	Certified Green Building	Required
Y			Prereq	Minimum Building Energy Performance	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Construction Activity Pollution Prevention	Required
			Credit	Certified Green Buildings	5
			Credit	Optimize Building Energy Performance	2
			Credit	Indoor Water Use Reduction	1
			Credit	Outdoor Water Use Reduction	2
			Credit	Building Reuse	1
			Credit	Historic Resource Preservation and Adaptive Reuse	2
			Credit	Minimized Site Disturbance	1
			Credit	Rainwater Management	4
			Credit	Heat Island Reduction	1
			Credit	Solar Orientation	1
			Credit	Renewable Energy Production	3
			Credit	District Heating and Cooling	2
			Credit	Infrastructure Energy Efficiency	1
			Credit	Wastewater Management	2
			Credit	Recycled and Reused Infrastructure	1
			Credit	Solid Waste Management	1
			Credit	Light Pollution Reduction	1
0	0	0		**Innovation & Design Process**	**6**
			Credit	Innovation	5
			Credit	LEED® Accredited Professional	1
0	0	0		**Regional Priority Credits**	**4**
			Credit	Regional Priority Credit: Region Defined	1
			Credit	Regional Priority Credit: Region Defined	1
			Credit	Regional Priority Credit: Region Defined	1
			Credit	Regional Priority Credit: Region Defined	1
0	0	0		**Project Totals (Certification estimates)**	**110**

Certified: 40-49 points, **Silver:** 50-59 points, **Gold:** 60-79 points, **Platinum:** 80+ points

Figure 2 LEED checklist for neighborhood development-built project

The Innovation & Design Process category, allocating 6 points for innovation and 1 point for LEED Participation of Accredited Professional shows that improvement and expertise in sustainable construction are ongoing. This category challenges project teams to think and practice beyond the set norms and engage in imaginative sustainable solutions as supported by Sepasgozar et al. (2020) who emphasise on the key factors of innovation and knowledge transfer in the construction sustainable development. The incorporation of this category in the checklist for LEED-ND shows the understanding that creating sustainable neighbourhoods can at times be an art and entails innovation in the use of the best technologies and methods. For example, projects may earn innovation credits through innovation in the waste management system, such an example as involving the community in climate change mitigation or coming up with more stringent and creative ways of dealing with climate change than is provided by the existing credits.

The fourth Regional Priority Credits category with 4 credits recognizes the concern with environmental, social and economic regional context of SD projects. This is consistence with Zhang and his colleague (2019) suggestion that sustainability assessment tools should be customized to suit the specific region of application to increase the chances of success. The LEED-ND system helps make credit priority possible and allows a richer, place-specific focus on sustainable neighbourhood establishment. This increases the understanding of the key local sustainability challenges in projects that affect water scarcity in areas with limited water supply, high temperatures and density of buildings and constructions in large metropolitan areas, or decreased population of animals and plants in regions that are particularly sensitive to human impact. The addition of these particular regional priority credits is thus consistent with the notion that although general concepts of sustainable development are useful, many country-specific practicalities can only be addressed by referencing conditions and priorities in any given area of the world.

4.4. Stakeholder Engagement and Collaborative Approaches in Sustainable Neighborhood Development

Neighbourhood development projects such as using sustainable construction when constructing commercial buildings must incorporate sound stakeholder management as well as work with multi-disciplinary teams in order to include sustainable principles both in design and throughout all the stages of the project. The LEED v4 for Neighborhood Development Built Project checklist indirectly embraces the notion on the need to involve stakeholders in the process through a number of credits that require the involvement of community members and the integration of professionals from various disciplines. For instance, the Neighborhood Pattern & Design category contains credits as Community Outreach and Involvement (2 points) to promote efforts of engagement with the community members in project tasks. This is in sync with Fei et al.,2021) perspective of the importance of embedding sustainability objectives and performance measures with various stakeholders, including the clients, designers, contractors, as well as the users. Thus, participation of the community in projects may assist in the enhancement of measures that are both sustainable and socially appropriate and feasible in the neighborhood. In addition, the engagement process will help identify local knowledge and preferences that can be useful in proposing more contextually suitable and sustainable designs that will help support the neighbourhood in the long run.

Because sustainable neighborhood development involves various disciplines as shown by the various categories of the LEED-ND checklist, team work involving various disciplines is essential. Taking an example of the Smart Location & Linkage category, it is executed with the contributions of urban planners, ecologists, and transportation specialists to identify the location and linkage degrees. Thus, the Green Infrastructure & Buildings category requires an involvement of architects and engineers in combination with sustainability consultants to ensure high-performance building designs as well as innovative infrastructure systems. This multidisciplinary approach is underlined by Yin et al. (2018) who have developed the integrated risk assessment built on the combination of the traditional project risks and sustainability risks. Thus, undertaking systematic identification of risks along with proper consideration of different stakeholders can help project teams improve the success rate of sustainable construction projects. Furthermore, the Innovation & Design Process specialization category, which creates incentives for innovation in sustainability, is most likely to problematize the interdisciplinary cross-collaboration that is needed for the development of new and sometimes unconventional approaches to problem-solving that may not neatly fit into conventional project-based work.

Somecredits within the LEED-ND checklist include several priorities that call for future consultant and community stewardship, committed by thenever ending nature of sustainable development projects such as the Long-Term Conservation Management of Habitat or Wetlands and Water Bodies (1 point). This corresponds with the guidelines of Hertwich et al. (2019) that promotes effectiveness in monitoring and evaluation systems used to measure sustainability performance at different stages of project delivery and even post-delivery. It is possible that some of the success factors can be achieved only through long-term management and monitoring of stakeholders, which would allow maintaining or even increasing the sustainability achieved in the planning phase. For example, training local members of community groups in ecological management of preserved green areas or entering into agreements with schools, colleges or universities for regular monitoring of green infrastructure projects can help in creating long term success factors needed for green infrastructure endeavours. Moreover, this long-term engagement means that the locals should feel an ownership of the facilities, and thus sustainability could go even further than the details of the development.

The Regional Priority Credits category of the LEED-ND checklist underline engagement with the stakeholders and collaborative methods with respect to regional specificities. It accredits with Sandanayake et al. (2018) who noted that the post occupancy evaluations and lifecycle assaults are important in affirming success of sustainable design solutions and outlining guidelines for the industry’s benchmark. When selecting credits that reflect a particular region’s environmental, social, or economic issues, project teams are motivated to consult those who are most informed about these problems. This may result in better and context-sensitive sustainable solutions. For instance, in arid areas cooperation with water supply organizations and environmental nongovernmental associations can be critical to generate unprecedented approaches for addressing the water deficiency challenge beyond conventional approaches. Likewise, when it comes to cities or towns with rich industrial roots, perhaps there is value for urban designers in consulting with local societies and industrial heritage conservationists in searching for solutions that would allow for the integration of the key client's sustainability objectives while respecting the local history. Besides, this regional approach to stakeholder engagement and collaboration adds to the outcome and development of context-specific best practices to be used for future sustainability projects.

5. Conclusion

The process of attaining sustainable neighborhood is a tiresome and time-consuming process that needs a radical change in the perception, planning, and implementation of the construction projects. Therefore, the context in which construction now takes place – at the onset of the era of rapid urbanization and constant environmental deterioration – requires introduction of sustainable construction practices. The analysis of specific critical factors and brushing up against the complex system of relationships of applying sustainable construction practices in project delivery and management, accompanied with understanding of the LEED v4 for Neighborhood Development, has shown endeavoring of connections that have to be knitted for reaching sustainable urban development. Right from the choice of project locations with least interference to the natural environment as well as maximization on connectivity to the creation of socially and economically sustainable vibrant urban human settlements to incorporation of state of art green building technologies and green infrastructures it takes innovation and an integrated approach. The LEED-ND checklist is not just a certification for communities but rather a path to innovative design of communities which supports natural systems as well human needs. As we have seen the successful management of sustainable construction involve a real balance between environmental management, social needs and the market forces. There is a peculiar focus on smart location and linkage which clearly points to the value of contextual planning that does not merely replace ecological and urban systems but progresses them. The emphasis on the pattern and organization of cities forces us to think about emerging urban forms that encourage active living, improved health and interactions among people. The application of green infrastructure and buildings challenges existing practice and innovation frontiers on resource use and environmental stewardship: realising the future of net positive urban environments. Further, the innovation and regional priorities acknowledged in LEED-ND, show the constant process of development of sustainability practices and acknowledgment of the contexts of certain regions. From the different sections of this paper, one can see how the different elements of the LEED-ND checklist are grounded on current research findings on sustainable construction and development of Neighborhoods. The research of Willar et al. (2021), Maqbool and Amaechi (2022), and Hertwich et al. (2019) revealed that the issue of sustainable development should be popular among scholars with the help of different methodological approaches from the level of a single building to the level of the whole neighborhood. Emphasis on the shareholder's involvement and integrated project delivery approach suggested by Fei et al. (2021) and Yin et al. (2018) simultaneously indicates that sustainable development is not just an engineering problem but also social and cultural in nature. Increasingly though, the spotlight has shifted towards what the future holds for sustainable neighborhood development The future will of course bring new challenges and opportunities which are likely to further need innovation, coordination, commitment from stakeholders in the built environment. Hence, it is the construction industry that is at the vanguard of such change, and holds the key to forging sustainable urban environments that can integrate technology, culture, and physical form, to create a built environment that will enable improved human wellbeing and minimise impacts of development on the earth's resources. But to achieve this the industry will have to overcome existing challenges such as fragmented value chain structures, short-term business VM practices, regulatory constraints and lack of information. It will entail a long-term process of learning and training since the practice of sustainable construction is making new and significant strides. This will require new mode of collaboration between governments and industries, Universities and industries nationally and internationally, and across disciplinary and geographical divides. At the end of this discussion of critical factors for practicing sustainable construction, one is left with impressions of daunting tasks that are ahead and exciting potentialities that are achievable. Thus, the LEED-ND and other prospective tools and approaches to sustainable development give us the map to tackle challenges of building sustainable districts. But it is up to us – as planners, designers, engineers, policy-makers and the citizens of this world to realize the vision, to go beyond the confines of the guidelines provided and to build the great cities that will accommodate generations to come and support human life and human endeavor on this planet.

Directions for Future Study

- Long-term performance evaluation: To investigate the real environmental, social and economic changes in certified neighborhoods in the long-term and compare the results with the expected values and 'control,' neighborhoods not designated LEED-ND.
- Integration of emerging technologies: Investigate the capability of newer technologies like Artificial Intelligence, Internet of things, Blockchain in improving the efficiency and conformity of sustainable construction measures at the neighborhood level.
- Adaptation to climate change: Investigate strategies for incorporating climate change resilience and adaptation

measures into sustainable neighborhood development, considering both physical infrastructure and social systems.

- Economic models for sustainability: Develop and test innovative financing mechanisms and business models that can overcome the barrier of higher upfront costs associated with sustainable construction practices.
- Cultural and behavioral aspects: Examine the role of cultural factors and human behavior in the success of sustainable neighborhoods, including studies on community engagement, lifestyle changes, and the long-term social impacts of sustainable urban design.
- Policy and governance: Analyze the effectiveness of various policy instruments and governance structures in promoting sustainable neighborhood development, with a focus on scalable and replicable models.
- Circular economy in construction: Investigate the application of circular economy principles in neighborhood-scale development, including material flows, waste management, and regenerative design approaches.
- Health and well-being metrics: Develop more comprehensive metrics and assessment tools for evaluating the health and well-being impacts of sustainable neighborhood design, integrating insights from public health, psychology, and urban planning.
- Global South context: Conduct more research on sustainable neighborhood development in the context of rapidly urbanizing regions in the Global South, addressing unique challenges and opportunities in these settings.
- Interdisciplinary collaboration: Explore new models for interdisciplinary collaboration in sustainable construction projects, identifying best practices for integrating diverse expertise throughout the project lifecycle.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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