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Advancing sustainable leadership in construction: Fostering a resilient society

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Abstract

The construction industry, essential for economic progress, faces significant challenges due to its resource-heavy practices and environmental footprint. As the need for sustainable development becomes increasingly urgent, effective leadership in this sector is crucial. This research aims to bridge a crucial knowledge gap by exploring the connection between sustainable leadership practices and the construction industry, with a focus on Pakistan. The study develops a detailed framework through a combination of literature review, expert evaluations, and rigorous statistical techniques. Data was gathered through a questionnaire completed by 206 professionals from Pakistan's construction industry. The research analyzes the impact of green building design, certification standards, life cycle assessment, renewable energy adoption, resilient infrastructure, social equity and inclusion, and waste management on sustainable leadership practices. Results demonstrate significant positive correlations between these aspects and sustainable leadership. This study provides valuable insights for both academic and industry audiences, offering a fresh perspective on how sustainable leadership can promote resilient and environmentally conscious construction practices. The findings have implications for policy development, industry transformation, and the creation of a sustainable and resilient built environment.

Keywords: Green building design; Certification standards; Life cycle assessment; Renewable energy adoption; Resilient infrastructure; Social equity and inclusion; Waste management

1. Introduction

The construction industry is crucial for the development of global infrastructure, contributing to both economic growth and social progress. However, traditional construction methods are increasingly scrutinized due to their high resource consumption and substantial environmental impact (Foldy and Ospina, 2023). For instance, the construction sector consumes nearly half of the world's steel, cement, energy, and other raw materials, leading to significant depletion of these finite resources (Indrayana and Pribadi, 2023; Ghorbani, 2023). Additionally, construction activities account for approximately 36% of global greenhouse gas emissions and nearly 40% of total global energy use. Furthermore, between 25% and 40% of global solid waste is attributed to construction and demolition activities (Gordeev, 2023).

The 21st century has seen an unprecedented emphasis on sustainable development, compelling many industries to align their practices with environmental, social, and economic sustainability (Anon, 2023; Nguyen and Nguyen, 2023). In this context, leadership in the construction sector becomes increasingly critical. Leaders have the ability to influence decision-making, drive innovation, and shape organizational culture. However, traditional leadership models often prioritize short-term profits over long-term sustainability (Das et al., 2023; Othman and Elwazer, 2023). This

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discrepancy has led to a broader recognition of the need for leadership approaches that evolve to address the sector's diverse challenges and opportunities (D'Ambrosio and Longobardi, 2023; Waqar et al., 2023).

The transition to more sustainable leadership is closely tied to building a resilient society and should be viewed as a practical necessity rather than just an idealistic goal. In an era marked by environmental instability, resource scarcity, and social complexity, it is crucial to develop robust infrastructure (Oyewobi and Jimoh, 2022). The increasing frequency and severity of climate-related disasters have resulted in over $3 trillion in global losses over the past decade, underscoring the urgent need for resilient infrastructure. Additionally, by 2050, approximately 70% of the global population will live in urban areas, increasing the demand for sustainable urban environments (Waqar et al., 2023; Zaman et al., 2023).

Despite the clear need for sustainable leadership in construction, there remains a notable gap in understanding how to effectively integrate and apply sustainable leadership principles (Hashim et al., 2022; Banmairuroy et al., 2022). While the urgency for sustainable leadership is recognized, research exploring the dynamic interplay between traditional leadership models and the demand of sustainable development is limited. Although existing literature provides some insights, a comprehensive framework that addresses this knowledge gap is still lacking (D'Ambrosio and Longobardi, 2023; Lopez Paredes et al., 2023). This paper aims to explore the complex relationship between sustainable leadership practices and the construction sector to address the gaps identified in previous research.

The construction industry, essential for global economic progress, faces an urgent challenge to enhance environmental sustainability and optimize resource use. This challenge, exacerbated by the resource-intensive nature of traditional construction practices, demands innovative solutions that go beyond mere recognition of the issue. Addressing the gap between challenges and solutions is crucial, with sustainable leadership emerging as a key factor. This research seeks to provide a thorough understanding of how sustainable leadership practices intersect with the sustainability issues faced by the construction industry, focusing specifically on Pakistan. By analyzing the interaction between sustainable leadership attributes and various aspects of sustainable construction practices, the study aims to develop a comprehensive conceptual framework that can guide industry transformation.

The need for environmental sustainability and efficient resource use in the construction industry is critical for global economic success. As traditional practices remain resource-intensive, innovative solutions are required to address these issues effectively. This study addresses the knowledge gap by investigating the intricate relationship between sustainable leadership practices and the challenges faced by the construction sector. It is distinctive for its focus on the intersection of sustainable leadership and construction in Pakistan, an area with limited previous research. The study stands out for its use of advanced research methods, including in-depth Structural Equation Modeling (S.E.M.), enhancing its rigor and findings.

The unique contribution of this study lies in its original approach to examining sustainable leadership practices within Pakistan's construction industry. While previous research has explored sustainable leadership in construction, this study distinguishes itself by integrating a literature review, expert analysis, and rigorous statistical methods to provide a comprehensive perspective. It covers a broader range of sustainability dimensions, including green building design, certification standards, life cycle assessment, renewable energy integration, resilient infrastructure, social equity and inclusion, and waste management.

By offering an in-depth analysis of sustainable leadership practices within the specific context of Pakistan, this study is a pioneering effort in construction industry research. Despite the extensive literature on sustainable building practices, there is a significant gap regarding the unique opportunities and challenges faced by the Pakistani construction industry. This study addresses this gap by developing a detailed framework that considers both traditional sustainability components and the unique dynamics of sustainable leadership within a specific geographical context. The research provides new insights into the complex issues faced by the construction sector in Pakistan and how sustainable leadership practices interact with these challenges. It lays the foundation for a deeper understanding of how sustainable leadership can drive transformative change within a given regional setting using advanced analytical tools and a comprehensive assessment of sustainability factors.

This article emerges from the need to understand the complexities of the construction sector's impact on the global landscape. It aims to close the knowledge gap on sustainable leadership, specifically within the construction industry. The research seeks to illuminate a path for leadership practices that not only build physical structures but also lay the groundwork for a resilient and sustainable society, addressing current needs without compromising the future. This will be achieved by analyzing the industry's challenges and opportunities. Figure 1 illustrates the study's hypothesis, showing that green building design, certification standards, life cycle assessment, renewable energy integration,

resilient infrastructure development, social equity and inclusion, and waste management have significant relationships with the implementation of sustainable leadership practices.

2. Literature Review

Sustainable Leadership (S.L.) has emerged as a response to the evolving and complex market conditions shaped by globalization, technological advancements, and various pressures such as instability and high performance demands. S.L. focuses on fostering innovative and sustainable solutions by enhancing the awareness, perspectives, and interactions of leaders and their followers (Oyewobi and Jimoh, 2022; Waqar et al., 2023). It aims to motivate and guide employees towards sustainability actions that benefit both current and future organizational goals, transcending traditional business practices. S.L. involves applying sustainability principles at every level—from individuals to organizations and societies—requiring personal commitment and a shift in mindset (Phinias, 2023). Sustainable development, a pressing global issue, necessitates reducing environmental impact while improving industry efficiency and competitiveness (Waqar and Othman, 2023; Dubljević et al., 2023). Despite this, there is a consensus among leaders and practitioners that sustainability efforts need to be more thoroughly integrated. This integration calls for advanced planning and management approaches that include educating, developing, innovating, connecting resources, and transforming practices (Mohamed and Eltohamy, 2022; Khan et al., 2023). Effective leadership is crucial for project success and relies heavily on collaboration with subordinates. Adopting a new leadership approach like S.L. is essential to overcoming challenges and ensuring the sustainability of construction organizations and communities (Khahro et al., 2023; Gbedemah, 2023).

In Pakistan, the construction industry plays a vital role in economic growth and social development but faces numerous challenges including low productivity, poor quality, cost overruns, delays, a shortage of skilled workers, environmental damage, and corruption (Khan et al., 2023; Waqar et al., 2023). These issues obstruct the adoption of green building practices, which, although voluntary, are crucial for setting sustainable standards and raising awareness. The Building Code of Pakistan Energy Provision 2011 is the sole regulatory framework supporting energy conservation in buildings, but it remains inadequately implemented and enforced. There is a clear need for S.L. to address these problems and secure the long-term viability of the construction industry and society in Pakistan (Khahro et al., 2023; Deng et al., 2023). However, there is a lack of empirical research on S.L. within the Pakistani construction industry, which limits understanding of its benefits, challenges, drivers, and practices (Madson et al., 2022; Bouhmoud et al., 2023).

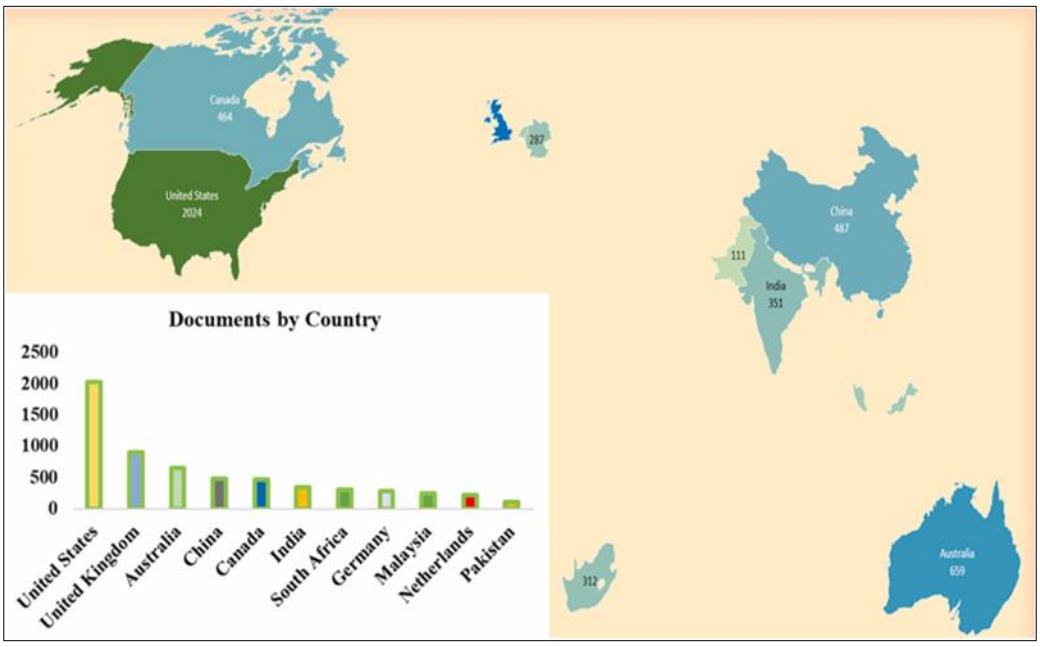

Figure 1 Documents by country 20133–2023 (Source SCOPUS database)

The literature review utilized the Scopus database to gather scholarly papers, research articles, and conference proceedings on sustainable leadership in the construction industry, particularly focusing on Pakistan. Inclusion criteria were established to select materials directly related to sustainable leadership practices within the sector, while exclusion criteria filtered out irrelevant documents. Figure 1 visually represents the global distribution of research

articles on sustainable leadership in construction, with the United States having the highest number of publications and Pakistan at the lower end. This illustration provides an overview of the global research landscape on the topic, highlighting the need for more focused research in Pakistan. Sustainable leadership differs from traditional leadership by emphasizing long-term prosperity rather than short-term gains, with leaders tasked with enhancing production while ensuring sustainability (Waqar et al., 2023; Quyen et al., 2023). Organizations often struggle to maintain a sustainable workforce across diverse cultural contexts (Karayel et al., 2023; Samuelsson et al., 2023). Effective succession planning is crucial for establishing a sustainable management structure (Waqar et al., 2023). Leaders must also develop their skills and self-awareness. Sustainable leadership comprises three key aspects: sustainable management, sustainable projects, and sustainability activities (Das et al., 2023). Figure 1 further illustrates the distribution of publications related to these themes, showing a greater focus in developed countries.

This literature review explores sustainable leadership practices in construction and their role in fostering a resilient society. It emphasizes long-term vision, balancing economic, social, and environmental aspects, and engaging diverse stakeholders (Ma et al., 2023; Ramis et al., 2023). Such practices are crucial for addressing challenges in the end-of-life phase of complex structures, which involves decisions on disposal or reuse (Ma et al., 2023; Cheung et al., 2023). Document searches and evaluations using V.O.S. Viewer, a bibliometric network visualization tool, supported this examination. Figure 2 displays the keywords related to sustainable leadership practices in construction and end-of-life decisions. The review highlights the current knowledge and identifies gaps and challenges for future research.

The construction industry's reliance on resources and its environmental impact are major concerns that transcend geographical boundaries (Latiffi and Zulkiffli, 2022; Larsen and Brandenburg, 2023). The industry significantly contributes to global resource use and waste generation (Oyewobi and Jimoh, 2022; Hashim et al., 2022). Its heavy dependence on energy and materials from finite sources not only depletes natural resources but also contributes to greenhouse gas emissions and climate change (Banmairuroy et al., 2022; Egwunatum et al., 2022). Historical challenges in waste management have led to environmental problems such as pollution and resource depletion (Maqbool et al., 2023; Gorecki et al., 2022). Given the global emphasis on environmental and social responsibility, the construction sector faces increasing pressure to adopt sustainable practices (Das et al., 2023; Bouhmoud et al., 2023). This review underscores the importance of sustainable leadership as a potential solution to these pressing issues, guiding the sector towards a more resilient and environmentally conscious future.

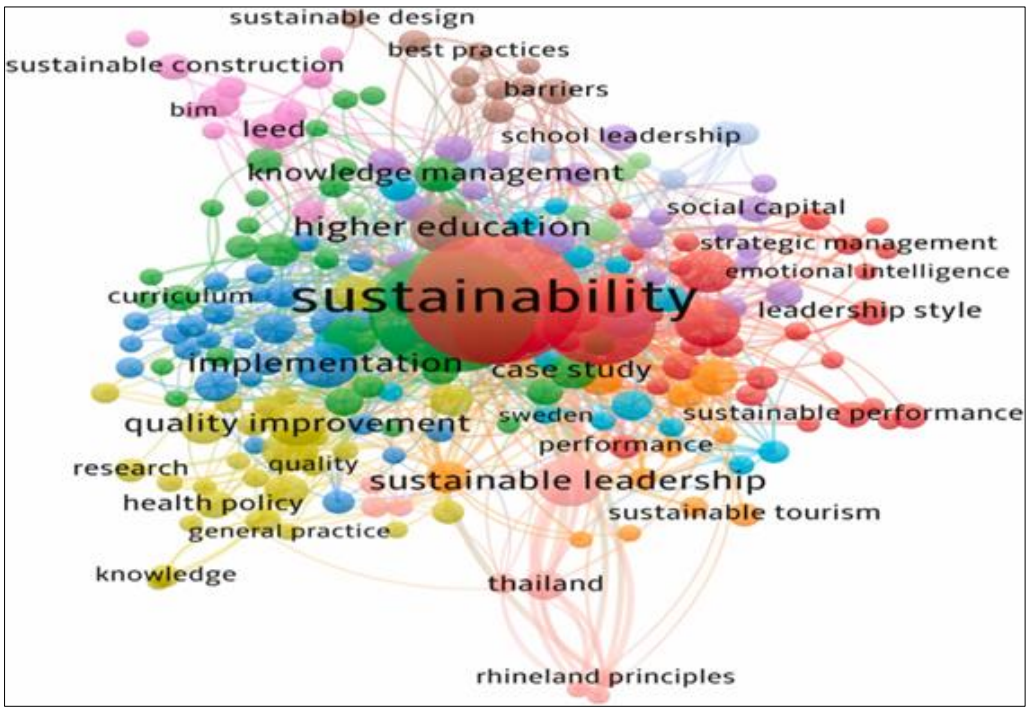

Figure 2 Visual representation of the keywords

The literature review reveals that sustainable leadership practices in construction can significantly contribute to building a resilient society amidst environmental, social, and economic challenges. It also highlights the need for empirical research on sustainable leadership in the Pakistani construction sector, which faces issues such as low

productivity, poor quality, corruption, and environmental degradation. The review identifies benefits, barriers, drivers, and practices of sustainable leadership and the tools and methods to measure and improve sustainability outcomes (Maqbool et al., 2023; Waqar et al., 2023). By uncovering the complexities of sustainable leadership practices and their interdependencies, the review provides a foundation for understanding how these practices can drive transformation in the construction industry, particularly in the context of Pakistan.

3. Methodology

This study was organized into four key phases to thoroughly investigate sustainable leadership practices within the construction industry. These phases are illustrated in Figure 3:

- Conceptual Study: This initial phase involved developing a research framework based on insights gathered from the literature. This framework laid the groundwork for understanding the various dimensions of sustainable leadership in the construction industry.
- Questionnaire Design: In the second phase, a detailed questionnaire was designed to gather quantitative data. This instrument aimed to capture various aspects of sustainable leadership practices as perceived by industry professionals and stakeholders.
- Structural Equation Modeling (S.E.M.) Analysis: The third phase involved testing hypotheses using S.E.M., a sophisticated statistical technique that enables the analysis of complex interactions among variables. This analysis was used to explore relationships between factors such as green building design, certification standards, life cycle assessment, renewable energy integration, resilient infrastructure, social equity and inclusion, and waste management in the context of sustainable leadership practices.
- Conclusion Phase: The final phase focused on discussing the results of the study, evaluating the success of the designed concept, and providing insights based on the findings from both quantitative and qualitative data.

Expert Analysis: To complement the quantitative data, expert analysis was conducted to provide a qualitative perspective. This analysis helped validate the findings from the questionnaire and offered deeper insights into sustainable leadership practices.

Literature Review Methodology: The literature review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, comprising the following steps:

- Identification: Searches were conducted in databases such as Scopus, PubMed, Web of Science, and Google Scholar using keywords like "sustainable leadership," "construction industry," "green building," and "Pakistan." The initial search yielded 1,250 items.
- Screening: Titles and abstracts were reviewed to filter out irrelevant studies, reducing the number to 600 articles. Publications not focused on sustainable leadership or the construction industry were excluded.
- Eligibility: Full-text reviews were conducted on the remaining articles to assess relevance and quality. Studies directly addressing sustainable building and leadership were included, while those lacking empirical evidence or focusing outside of Pakistan were excluded, resulting in 300 articles.
- Inclusion and Data Extraction: A total of 150 articles met the inclusion criteria and were used for detailed data extraction. Key elements such as results, methodologies, geographic focus, and theoretical frameworks were summarized.
- Synthesis: The final step involved synthesizing the data from these 150 publications to gain a comprehensive understanding of sustainable leadership in construction, particularly in Pakistan, and to identify gaps and opportunities for future research.

Structural Equation Modeling (S.E.M.): S.E.M. was employed to model and analyze complex interactions among various factors affecting sustainable leadership. This method facilitates the exploration of causal relationships and interactions among different elements of sustainable leadership, providing a detailed view of how these factors interrelate and influence each other.

Integration of Methodologies: The integration of both quantitative (via questionnaires and S.E.M.) and qualitative (via expert analysis) data provided a holistic perspective on sustainable leadership practices in the Pakistani construction industry. This approach enabled the research to bridge theoretical frameworks with empirical evidence, offering valuable insights into how sustainable leadership can drive the adoption of environmentally aware practices and enhance the industry's resilience to challenges and changes (Mohamed and Eltohamy, 2022; Maqbool et al., 2023).

Overall, the study aims to contribute significantly to the field by elucidating how sustainable leadership can facilitate the adoption of environmentally conscious practices and improve the construction industry's ability to adapt to evolving demands.

3.1. Identification of Factors through Literature

This section outlines the methodology employed to systematically identify and extract essential elements related to sustainable leadership practices in the construction sector. The process was designed to build a comprehensive foundation for future analyses and discussions.

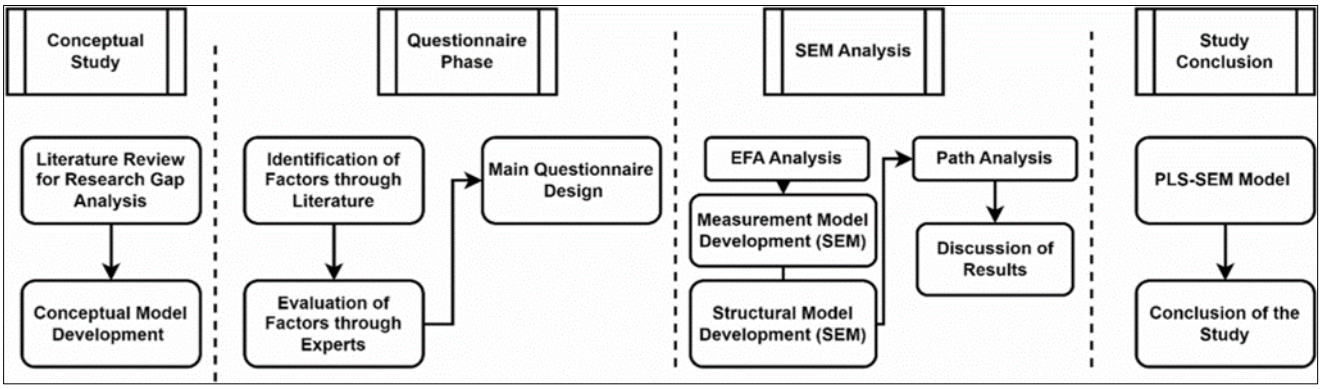

Figure 3 Literature Factor

3.1.1. Methodology Overview:

- Systematic Literature Review: A systematic review approach was chosen due to its rigorous and structured method for collecting and examining relevant scholarly articles. This method involves predetermined search criteria, a carefully designed search strategy, and a stringent selection process.
- Search Strategy:
  - Databases Used: Scopus, Web of Science, and Google Scholar.
  - Search String: `"sustainable leadership practices in construction" AND "Pakistan" AND "green building design" OR "certification standards" OR "life cycle assessment" OR "renewable energy integration" OR "resilient infrastructure" OR "social equity and inclusion" OR "waste management"`.
  - Time Frame: The search focused on literature from the last decade.
- Selection Criteria:
  - Inclusion: Peer-reviewed research publications, conference proceedings, and reports specifically addressing sustainable leadership practices in the construction industry, with an emphasis on the Pakistani context.
  - Exclusion: Non-peer-reviewed articles and studies not directly relevant to sustainable leadership or thosefocused outside Pakistan.
- Thematic Analysis:
  - Data Extraction: Relevant information was methodically extracted from selected studies, focusing on key aspects related to environmentally responsible leadership practices.
  - Classification and Integration: Extracted data was organized into consistent themes through thematic analysis, identifying overarching patterns and trends.
- Expert Review:
  - Expert Involvement: Input from specialists in sustainable leadership, construction management, and sustainable development was sought to validate and enhance the identified factors and themes.
  - Iterative Process: Recommendations from experts were integrated into the framework to improve its robustness and relevance.

3.1.2. Framework Development:

- Outcome: The methodical identification of relevant research led to the development of a framework that outlines key factors influencing sustainable leadership in construction. This framework serves as the foundation for future empirical research and model validation.

3.1.3. Key Elements Identified:

- Social Inclusion
- Ethical Decision-Making
- Environmental Responsibility
- Economic Viability

3.1.4. Significance

- Comprehensive Understanding: The identified factors provide a comprehensive view of sustainable leadership practices and contribute to the broader understanding of sustainable development in the construction sector.
- Future Research: The framework sets the stage for further empirical investigation and model validation, aiming to address gaps and advance knowledge in sustainable leadership within the construction industry, particularly in Pakistan (Gorecki et al., 2022; Turnbull et al., 2023).

This systematic approach ensures that the research is grounded in a solid foundation of existing knowledge, paving the way for more nuanced analyses and discussions on sustainable leadership practices in the construction sector.

3.2. Evaluation of Factors through Expert Analysis

The expert analysis was conducted to enhance the credibility and completeness of the synthesis framework for sustainable leadership practices in the construction sector. This evaluation involved sixteen highly experienced industry professionals, each with over 15 years in the building and construction industry, many of whom have held leadership and management roles.

3.2.1. Evaluation Process:

- Selection of Experts:
  - Criteria: Experts were selected based on their extensive experience and leadership roles within the industry. Their in-depth knowledge was crucial for providing valuable insights into effective and environmentally responsible leadership practices (Waqar et al., 2023h, 2023i).
- Presentation of Framework:
  - Compilation: The factors identified from the literature were compiled into an organized framework. This included explanations of the elements, thematic groupings, and their implications for fostering sustainable leadership in construction (Mergos, 2023; Tran et al., 2023).
  - Explanation: The presentation aimed to clarify how these elements contribute to sustainable leadership practices.
- Expert Participation:
  - Method: Experts provided their insights through interviews or questionnaires. Their feedback covered validation, refinement, and potential enhancements of the framework, reflecting their practical experience (Banmairuroy et al., 2022; Lühr et al., 2023).
- Synthesis of Insights:
  - Analysis: The insights from the expert panel were carefully synthesized to identify common themes, convergences, and divergences. This analysis helped in crystallizing visible patterns and refining the framework (Hashim et al., 2022; Egwunatum et al., 2022).
- Iterative Review:
  - Process: The evaluation followed an iterative approach, with multiple rounds of expert feedback and revisions. This allowed for a thorough and multifaceted review, integrating diverse perspectives (Jiang et al., 2022; Elkhapery et al., 2023).
- Triangulation:
  - Comparison: Findings from the expert analysis were compared with those from the preliminary literature review. This triangulation method validated the resonance between academic viewpoints and practical industrial knowledge (Lopez ´ Paredes et al., 2023; Elkhapery et al., 2023).
- Framework Enhancement:
  - Outcome: The expert analysis led to an improved framework, incorporating valuable contributions and insights. This enhanced framework serves as a robust resource for further analyses, discussions, and empirical studies (Lopez ´ Paredes et al., 2023; Zhang and Dong, 2023).

3.2.2. Significance

- Validation: The expert analysis provided validation and refinement of the framework, ensuring that it accurately reflects practical and theoretical perspectives on sustainable leadership.
- Enhanced Framework: The refined framework is poised to facilitate deeper understanding and future research in sustainable leadership within the construction industry.

This meticulous evaluation process ensured that the framework is well-founded and comprehensive, integrating both theoretical and practical insights to support sustainable leadership practices in the construction sector.

3.3. Questionnaire Plan

The questionnaire was developed to assess sustainable leadership practices within the construction sector, drawing on factors identified through literature review and expert analysis. This quantitative research approach aimed to provide empirical insights that could inform future research and policy decisions.

3.3.1. Overview of the Questionnaire Methodology:

- Objective

The questionnaire was designed to gather quantitative data on sustainable leadership practices in the construction industry in Rawalpindi, Pakistan. The data collected aimed to address the following hypotheses (as shown in Fig. 4):

  - H1: Green building design positively affects sustainable leadership practice.
  - H2: Green certification and standards positively affect sustainable leadership practice.
  - H3: Lifecycle assessment positively affects sustainable leadership practice.
  - H4: Renewable energy integration positively affects sustainable leadership practice.
  - H5: Resilient infrastructure development positively affects sustainable leadership practice.
  - H6: Social equity and inclusion positively affect sustainable leadership practice.
  - H7: Waste management and recycling positively affect sustainable leadership practice (Banmairuroy et al., 2022; Egwunatum et al., 2022).
- Design and Distribution:
  - Questionnaire Design: The questionnaire used a five-point Likert scale to measure respondents' attitudes toward various sustainable leadership practices, such as environmental stewardship, ethical decision-making, social inclusion, and economic viability (Lopez ´ Paredes et al., 2023; Elkhapery et al., 2023).
  - Distribution: The questionnaire was distributed via email and personally to local experts in Rawalpindi to ensure convenience and maximize response rates. A total of 296 individuals were contacted, resulting in a 69% response rate with 206 valid replies (Hashim et al., 2022; Banmairuroy et al., 2022; Lopez ´ Paredes et al., 2023).
- Sample Selection:
  - Participants: The study targeted professionals within the construction industry, including architects, engineers, project managers, and sustainability experts. This purposive sampling aimed to include individuals with relevant experience and knowledge (Egwunatum et al., 2022; Gorecki ´ et al., 2022).
  - Geographical Focus: Participants were selected from across Pakistan to ensure a diverse range of responses, with a focus on Rawalpindi as a key metropolitan hub in the construction sector (Tran et al., 2023; Hu and Shu, 2023).
- Ethical Considerations:
  - Ethics: The study adhered to strict ethical guidelines, including obtaining informed consent from participants to uphold research integrity and credibility. The questionnaire's design and data collection processes were conducted with a strong emphasis on ethical standards (Banmairuroy et al., 2022; Egwunatum et al., 2022).
- Data Analysis:
  - Quantitative Analysis: The collected data were analyzed statistically to provide empirical insights into sustainable leadership practices. This analysis aimed to validate the hypotheses and provide meaningful comparisons (Waqar et al., 2023h; Hu and Shu, 2023).

3.3.2. Significance

- Data Quality: The use of a structured Likert-scale questionnaire and a well-defined sample helped ensure that the data collected were reliable and representative of the construction industry's perspectives on sustainable leadership.

- Impact: The insights gained from this questionnaire are expected to contribute significantly to understanding sustainable leadership practices in the local context and inform future research and policy development.

Overall, the methodological approach combined rigorous questionnaire design and quantitative analysis to assess sustainable leadership practices effectively within the construction sector in Pakistan.

3.4. Structural Equation Modeling (S.E.M.) Analysis

Structural Equation Modeling (SEM) is employed to analyze the relationships between latent variables and observed indicators in this study. The methodology involves both Exploratory Factor Analysis (EFA) and Partial Least Squares Structural Equation Modeling (PLS-SEM) to ensure a comprehensive examination of the data.

- Exploratory Factor Analysis (E.F.A.):
  - Objective: EFA is used to identify underlying latent variables that represent sustainable leadership practices.
- Method: Principal Component Axis was chosen as the extraction method, focusing on factors with Eigenvalues greater than 1.0. The Varimax rotation method was applied to enhance interpretability. Only items with loadings greater than 0.6 were retained for each factor (Dubljevi´c et al., 2023; Khahro et al., 2023).
- Partial Least Squares Structural Equation Modeling (PLS-SEM):
  - Measurement Modeling:
  - Software: SmartPLS 4 was utilized for conducting PLS-SEM analysis.
  - Convergent Validity: Assessed through item loadings (must be higher than 0.7) and Average Variance Extracted (AVE) values (must be higher than 0.5). This ensures that each construct is well-represented by its indicators (Phinias, 2023; Waqar and Othman, 2023).
  - Discriminant Validity: Evaluated by comparing the square root of the AVE for each construct with its correlations with other constructs. Discriminant validity is confirmed if the square root of the AVE is greater than its correlations with other constructs, with a recommended cutoff of 0.85 (Mohamed and Eltohamy, 2022; Madson et al., 2022).
  - Cross-Loadings: Cross-loadings are assessed to ensure that indicators load more heavily on their intended constructs than on other constructs. This helps verify discriminant validity (Quyen et al., 2023; Samuelsson et al., 2023).
- Structural Model Analysis
  - Bootstrapping Method: To analyze the structural model, 5000 bootstrap samples were used. This method allows for the computation of path coefficients, standard errors, t-statistics, and p-values (Ma et al., 2023; Ramis et al., 2023).
  - Hypothesis Testing: Hypotheses are considered supported if the path coefficients are significant ($p < 0.05$) and the t-values exceed 1.96 at a 95% confidence level.
- Predictive Relevance (Q2) Test:
  - Objective: Assessed using SmartPLS 4 to determine the model's predictive relevance. A positive Q2 value indicates that the model has predictive relevance and can forecast changes in the endogenous latent constructs and their indicators.

This comprehensive SEM approach combines EFA and PLS-SEM to robustly test and validate the proposed hypotheses about sustainable leadership practices in the construction sector.

4. Results and Analysis

4.1. Identified Factors Through Literature and Expert Analysis

Table 1 provides a comprehensive summary of the identified criteria for sustainable leadership practices within the construction sector, as derived from the literature and validated by domain experts. These factors are categorized into thematic groupings that illuminate various aspects of sustainable leadership:

- Green Building Design:
  - Overview: This category emphasizes the importance of integrating environmentally responsible policies and procedures into building design. Key actions include reducing resource consumption, selecting eco-friendly materials, and implementing energy-efficient technologies.
  - Significance: By adopting these practices, organizations minimize their environmental impact and align with industry advancements, positioning themselves as leaders in sustainability (Quyen et al., 2023; Samuelsson et al., 2023).

- Waste Management and Recycling:
  - Overview: This group focuses on the necessity of implementing effective waste management and recycling strategies. Such methods reduce waste generated by construction projects, alleviate landfill burdens, and mitigate environmental harm from waste disposal.
  - Significance: These practices not only adhere to sustainable leadership principles but also prioritize the management of durability, safety, and community well-being (Waqar et al., 2023f).
- Renewable Energy Integration:
  - Overview: Incorporating renewable energy sources like solar, wind, and geothermal power is crucial for advancing sustainable energy practices.
  - Significance: This approach reduces carbon footprints and supports the broader transition towards renewable energy (Yun, 2023; Waqar et al., 2023f).
- Life Cycle Assessment:
  - Overview: Conducting life cycle assessments is essential for evaluating sustainability comprehensively. It involves assessing the environmental impact of projects throughout their lifecycle.
  - Significance: This method enables organizations to make informed decisions that minimize their overall environmental footprint and promote ethical business practices (Li et al., 2023).
- Green Certification & Standards:
  - Overview: Acquiring environmental certifications and adhering to established standards validate an organization's commitment to sustainability.
  - Significance: This not only legitimizes sustainable practices but also encourages industry-wide adoption of responsible norms, enhancing overall environmental performance (Samuelsson et al., 2023; Waqar et al., 023e).
- Social Equity & Inclusion:
  - Overview: This category underscores the importance of promoting social equity and inclusive growth. It involves addressing issues like social fairness, affordable housing, job opportunities for underserved populations, and community engagement.
  - Significance: Prioritizing these factors demonstrates a commitment to societal well-being and aligns with sustainable leadership values (Waqar et al., 2023f; Yun, 2023).

4.1.1. Conclusion

The results presented in Table 1 reflect a broad spectrum of sustainable leadership criteria in the construction sector. Both academic research and expert opinions validate these factors, highlighting the industry's progress toward creating a resilient, inclusive, and environmentally responsible built environment. Each category of variables contributes to this overarching goal, emphasizing the importance of informed decision-making and strategic implementation of sustainable leadership practices to address contemporary challenges and benefit society and the environment (Li et al., 2023; Ramis et al., 2023).

4.2. Demographic Details of Questionnaire Respondents

Table 2 provides detailed demographic information about the participants of the questionnaire. This data includes insights into gender distribution, professional experience, and occupational positions, reflecting the diversity and depth of the sample:

Gender Distribution: The sample was predominantly male, comprising 86% of the respondents. This distribution highlights the gender imbalance within the construction industry, which may influence perspectives on sustainable leadership practices.

- Professional Experience: Participants had varied levels of experience:
  - 36% had 11 to 15 years of experience.
  - 26% had 6 to 10 years of experience.
  - This range indicates a mix of both seasoned professionals and those with substantial, but slightly less experience, contributing to a broad understanding of sustainable leadership practices.
- Occupational Positions:
  - 42% were civil engineers.
  - 33% were project managers.
  - 20% were safety managers.
  - The diversity in occupational roles provides a well-rounded perspective on sustainable leadership practices, incorporating insights from various critical areas within the construction sector.

The varied backgrounds of the respondents enrich the study by offering a wide range of viewpoints and a deeper understanding of sustainable leadership methods in the construction industry. This diversity helps ensure that the findings are comprehensive and reflective of different facets of the industry.

4.3. Structural Equation Modeling (S.E.M.) Analysis

4.3.1. EFA Analysis

Table 3 presents a comprehensive summary of the results from the Exploratory Factor Analysis (E.F.A.), detailing the extracted components, variable loadings, and Cronbach's alpha values for each factor related to sustainable leadership practices. The E.F.A. aimed to uncover latent constructs represented by observed variables and used Cronbach's alpha to assess the internal consistency of these components.

- - Findings and Variable Loadings:
  - The "Green Building Design" (G.B.D.) factor showed variable loadings between 0.708 and 0.857, indicating strong correlations with the underlying construct.
  - The "Waste Management & Recycling" (W.M.R.) factor displayed loadings from 0.682 to 0.841, suggesting consistent associations with the latent construct.
  - The "Resilient Infrastructure Development" (R.I.D.) factor had loadings ranging from 0.604 to 0.811, reflecting its varied connections with different variables.
  - Similar patterns were observed for other factors including "Renewable Energy Integration" (R.E.I.), "Life Cycle Assessment" (L.C.A.), "Green Certification & Standards" (G.C.S.), and "Social Equity & Inclusion" (S.E.I.).
- Extraction and Rotation Methods:
  - Principal Component Analysis was utilized for extraction.
  - Varimax rotation with Kaiser normalization was applied to enhance the interpretability of the factors.
- Omission of Variables:
  - Variables with loadings below 0.6, such as GBD5, WMR5, REI2, LCA5, GCS5, SEI2, and SEI3, were excluded from the analysis. These variables had weaker connections with their corresponding latent constructs compared to others.
- Internal Consistency:

The analysis emphasized the Cronbach's alpha values, which are crucial for assessing the reliability of each factor. The results help establish the credibility and dependability of the framework for sustainable leadership practices in the construction sector.

In summary, Table 3 highlights the E.F.A. results, focusing on the strength of variable loadings and the internal consistency of identified factors. This analysis clarifies the relationships between observable variables and latent constructs, enhancing the framework's reliability for sustainable leadership practices within the construction industry (Hashim et al., 2022; Tran et al., 2023).

4.3.2. PLS Measurement Modeling

Evaluation of Convergent Validity

Table 4 provides a thorough assessment of convergent validity for each group within the sustainable leadership practices framework. This assessment uses Cronbach's Alpha (C.A.), Composite Reliability (C.R.), and Average Variance Extracted (AVE) to gauge the reliability and consistency of the measurement model.

- Convergent Validity Metrics:
  - Cronbach's Alpha (C.A.): Measures the internal consistency of each construct. Higher C.A. values indicate stronger internal consistency.
  - Composite Reliability (C.R.): Assesses how well the group components measure the underlying concept.
  - Average Variance Extracted (AVE): Evaluates the amount of variance captured by the construct relative to measurement error.
- Findings:
  - Green Building Design (G.B.D.): Items GBD1, GBD3, and GBD4 have significant loadings (0.820, 0.819, and 0.952, respectively). GBD2 was excluded due to low loading. A Variance Inflation Factor (V.I.F.) over 2.0 indicates potential multicollinearity.
  - Other Constructs: Similar evaluations are done for constructs like Waste Management & Recycling, Renewable Energy Integration, etc., to ensure robust convergent validity.

- Reliability and Validity:
  - High C.A. and C.R. values for most components confirm convergent validity. Items with low factor loadings were removed to refine the measurement model. V.I.F. values should ideally be below 5 to mitigate multicollinearity.

Discriminant Validity

Table 5 displays the results from the Heterotrait-Monotrait Ratio of Correlations (HTMT) analysis, used to test discriminant validity.

- HTMT Values
  - Green Building Design vs. Green Certification & Standards: HTMT value of 0.316 indicates good discriminant validity, as it is below the 0.85 threshold.
  - Other Constructs: HTMT values for other pairs are assessed to confirm whether constructs are distinct from each other.

Fornell-Larcker Criteria

Table 6 summarizes the Fornell-Larcker criteria results for assessing discriminant validity.

- Evaluation Method:
  - Compares the correlation between constructs to the square root of each construct's AVE. Discriminant validity is confirmed if the AVE is greater than the correlation values.
- Findings:
  - Green Building Design (G.B.D.): Correlation value of 0.866 with itself, which is higher than its AVE (0.75), suggesting a lack of discriminant validity.
  - Green Certification & Standards vs. Green Building Design: Correlation value of 0.291 is below the AVE values of both constructs, indicating discriminant validity.

Cross Loading Criterion

Table 7 presents the results from the Cross Loading Criterion analysis, focusing on discriminant validity by examining how variables load on their target construct versus others.

- Findings
  - Variables should have higher cross-loadings on their target construct compared to others. P-values consistently below 0.005 confirm the statistical significance of these relationships.
  - Overall, Tables 4 through 7 provide a comprehensive analysis of convergent and discriminant validity, confirming the reliability and distinctness of the constructs in the sustainable leadership practices framework. These analyses ensure that the measurement model effectively captures the different approaches to sustainable leadership in the construction sector.

5. Discussion

This research delves into sustainable leadership practices within the construction industry, an area of increasing importance due to growing concerns about environmental preservation and societal well-being. By combining literature review, expert opinions, and rigorous statistical analyses, this study aims to elucidate the relationships between various sustainable practices and overall sustainable leadership in construction.

5.1. Hypothesis Testing

5.1.1. Hypothesis 1: Green Building Design and Sustainable Leadership Practices

- Findings: A statistically significant path coefficient of 0.101 with a T-statistic of 6.291 indicates a positive impact of green building design on sustainable leadership practices. This supports the idea that integrating environmentally conscious design principles enhances sustainable leadership.
- Conclusion: Hypothesis 1 is accepted, affirming the importance of incorporating green building practices into leadership strategies to bolster sustainability (Egwunatum et al., 2022; Jiang et al., 2022).

5.1.2. Hypothesis 2: Green Certification and Standards and Sustainable Leadership Practices

- Findings: A high path coefficient of 0.212 and a T-statistic of 37.407 demonstrate that adherence to green certifications and standards significantly promotes sustainable leadership practices.
- Conclusion: Hypothesis 2 is strongly supported, highlighting the role of certifications in advancing sustainable leadership.

5.1.3. Hypothesis 3: Life Cycle Assessment and Sustainable Leadership Practices

- Findings: A path coefficient of 0.087 and a T-statistic of 4.685 show that considering the entire life cycle of projects significantly impacts sustainable leadership practices.
- Conclusion: Hypothesis 3 is supported, emphasizing the importance of life cycle assessments in fostering sustainable leadership (Hashim et al., 2022; Lühr et al., 2023).

5.1.4. Hypothesis 4: Renewable Energy Integration and Sustainable Leadership Practices

- Findings: A significant path coefficient of 0.244 and a T-statistic of 40.223 indicate that integrating renewable energy sources has a substantial positive effect on sustainable leadership practices.
- Conclusion: Hypothesis 4 is unequivocally supported, underscoring the critical role of renewable energy in promoting sustainable leadership (Egwunatum et al., 2022; Elkhapery et al., 2023).

5.1.5. Hypothesis 5: Resilient Infrastructure Development and Sustainable Leadership Practices

- Findings: A path coefficient of 0.126 and a T-statistic of 11.113 highlight the positive influence of resilient infrastructure development on sustainable leadership practices.
- Conclusion: Hypothesis 5 is strongly supported, pointing to the importance of robust and flexible infrastructure for effective sustainable leadership (Waqar and Ahmed, 2023; Waqar et al., 2023l).

5.1.6. Hypothesis 6: Social Equity and Inclusion and Sustainable Leadership Practices

- Findings: A substantial path coefficient of 0.244 and a robust T-statistic of 40.13 demonstrate that social equity and inclusion are crucial for sustainable leadership.
- Conclusion: Hypothesis 6 is accepted, emphasizing the connection between social responsibility and effective leadership for sustainability (Lopez Paredes et al., 2023; Latiffi and Zulkiffli, 2022).

5.1.7. Hypothesis 7: Waste Management and Recycling and Sustainable Leadership Practices

- Findings: A significant path coefficient of 0.242 and a T-statistic of 40.829 indicate that effective waste management and recycling practices are vital for sustainable leadership.
- Conclusion: Hypothesis 7 is adopted, highlighting the importance of waste reduction and responsible disposal strategies in sustainable leadership (Tran et al., 2023; Lühr et al., 2023).

5.2. Contributions and Theoretical Implications

This study makes a significant contribution to understanding sustainable leadership in the construction industry by confirming positive relationships between various sustainable practices and overall leadership effectiveness. The findings provide a robust framework for guiding decision-making and strategic planning, helping organizations align their leadership practices with sustainability goals.

The research also expands theoretical perspectives on sustainable leadership by adopting a multi-dimensional approach to sustainability. This approach emphasizes the need for leaders to address multiple facets of sustainability concurrently, including environmental, social, and operational aspects, to effectively contribute to environmental preservation, societal well-being, and long-term organizational success (Mohamed and Eltohamy, 2022; Waqar et al., 2023g).

6. Conclusion

The construction industry is at a pivotal moment where the adoption of sustainable practices is no longer optional but essential. This manuscript delves into sustainable leadership practices within this sector, shedding light on the complex relationships that contribute to a resilient and environmentally conscious development approach. By integrating

comprehensive literature reviews, expert insights, and rigorous statistical analyses, this study advances our understanding of the critical aspects of sustainable leadership in construction.

Key Findings

The study underscores the significant impact of various sustainable practices on leadership within the construction industry. The positive relationships identified between Sustainable Leadership Practices and key dimensions—such as Green Building Design, Green Certification & Standards, Life Cycle Assessment, Renewable Energy Integration, Resilient Infrastructure Development, Social Equity & Inclusion, and Waste Management & Recycling—demonstrate the interconnectedness of these elements. These findings suggest that as organizations embrace these practices, their leadership strategies gain a heightened focus on environmental responsibility, social equity, and economic viability.

The robustness of these relationships is highlighted by high path coefficients and T-statistic values, which affirm the statistical significance of the findings. Additionally, the predictive relevance analysis enhances the model's credibility, illustrating its effectiveness in guiding and directing sustainable leadership initiatives in construction.

Practical Implications

Organizations can leverage these insights to enhance their leadership practices, achieving positive outcomes for their bottom lines, the environment, and society at large. The integration of green building principles, inclusive practices, and responsible waste management into leadership strategies forms a comprehensive framework for fostering sustainable leadership.

Limitations and Future Research

The study acknowledges several limitations:

- Sample Size: The moderate sample size may limit the generalizability of the results. A larger and more diverse sample could offer a deeper understanding of sustainable leadership practices in construction.
- Cross-Sectional Design: The cross-sectional nature of the study provides a snapshot of associations at a single point in time. Longitudinal research could offer insights into the evolving dynamics of sustainable leadership over extended periods.
- Geographical Focus: The research primarily examines the construction industry in Pakistan. Results may not be directly applicable to other regions due to varying legal, cultural, and economic contexts.
- Self-Reported Data: Dependence on self-reported data may introduce response bias and may not fully reflect the actual practices of construction organizations.

In conclusion, this manuscript captures the essence of sustainable leadership practices within the construction industry. It emphasizes the need to integrate sustainable practices into leadership strategies, promoting a balance between economic development, environmental stewardship, and social equity. By providing a robust foundation for understanding and implementing these practices, this research contributes to the ongoing discourse on sustainable leadership. The way forward involves translating these insights into actionable practices, fostering a future where construction leadership stands as a model of sustainable development, resilience, and progress.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Anon, 2023. In: Proceedings of the 1st International Conference and Symposium on Construction Industry Development: Value Added Construction, 2599. American Institute of Physics Inc.

[2] Banmairuroy, W., Kritjaroen, T., Homsombat, W., 2022. The effect of knowledge- oriented leadership and human resource development on sustainable competitive advantage through organizational innovation's component factors: evidence from Thailand 's new S- curve industries. Asia Pac. Manag. Rev. https://doi.org/10.1016/j.apmrv.2021.09.001.

[3] Bouhmoud, H., Loudyi, D., Giordano, A., Azhar, S., Farah, M., 2023. Exploratory study of the gender equity in the North African AEC industry and academia: ratios, causes and remedial actions. In: Proceedings of the 2023 International Interdisciplinary PhD Workshop IIPhDW 2023. Mohammedia, Morocco. Institute of Electrical and Electronics Engineers Inc.: University Hassan Ii of Casablanca, Faculty of Sciences and Technics of Mohammedia (FSTM).

[4] Chen, J., Walker, A.D., Riley, P., 2023. Reconceptualizing principal well-being: state, measurement and consequences. J. Educ. Adm. 61, 495–513. https://doi.org/ 10.1108/JEA-12-2022-0224.

[5] Cheung, C., Chih, Y.Y., Bowen, P., Liao, P.C., 2023. Leadership and employee well-being in the architecture, engineering, and construction (AEC) industry. J. Manag. Eng. 39 https://doi.org/10.1061/JMENEA.MEENG-5491.

[6] D'Ambrosio, R., Longobardi, A., 2023. Adapting drainage networks to the urban development: an assessment of different integrated approach alternatives for a sustainable flood risk mitigation in northern Italy. Sustain. Cities Soc. 98 https://doi. org/10.1016/j.scs.2023.104856.

[7] Das, P., Perera, S., Senaratne, S., Osei-Kyei, R., 2023. A smart modern construction enterprise maturity model for business scenarios leading to industry 4.0. Smart Sustain. Built Environ. https://doi.org/10.1108/SASBE-09-2022-0205.

[8] Deng, H., Wu, M., Yang, Z., He, Y., Zhu, L., Zhao, Q., Dai, H., Wu, J., Liao, X., Zhang, Y., 2023. Construction of an innovative model of chronic disease management in compact county medical alliance with treatment-prevention integration. Chin. Gen. Pract. 26, 2720–2725. https://doi.org/10.12114/j.issn.1007-9572.2023.0150.

[9] Dubljevi´c, S., Tepav˘cevi´c, B., Markoski, B., Anđelkovi´c, A.S., 2023. Computational BIM tool for automated LEED certification process. Energy Build. 292 https://doi.org/ 10.1016/j.enbuild.2023.113168.

[10] Egwunatum, S.I., Anumudu, A.C., Eze, E.C., Awodele, I.A., 2022. Total quality management (TQM) implementation in the Nigerian construction industry. Eng.

[11] Constr. Archit. Manag. https://doi.org/10.1108/ECAM-08-2020-0639.

[12] Elkhapery, B., Kianmehr, P., Doczy, R., 2023. Tradeoff between well-being of students and cost of greening schools in arid regions. Manag. Environ. Qual. Int. J. 34, 794–819. https://doi.org/10.1108/MEQ-09-2022-0249.

[13] Foldy, E.G., Ospina, S.M., 2023. Contestation, negotiation, and resolution': the relationship between power and collective leadership. Int. J. Manag. Rev. 25, 546–563. https://doi.org/10.1111/ijmr.12319.

[14] Gorecki, J., Nú´ nez-cacho, P., Rutkowska, M., 2022. Study on circular economy ˜ implementation propensity of construction companies in context of prevailing management styles. Appl. Sci. 12 https://doi.org/10.3390/app12083991.

[15] Gbedemah, S.F., 2023. Eruditing from indigenous adaptation strategies for resilient and sustainable coastal erosion management in Southeastern Ghana. Discov. Sustain. 4 https://doi.org/10.1007/s43621-023-00123-z.

[16] Ghorbani, A., 2023. A review of successful construction project managers' competencies and leadership profile. J. Rehabil. Civ. Eng. 11, 76–95. https://doi.org/10.22075/ JRCE.2022.24638.1560.

[17] Gordeev, P.N., 2023. I stayed in the hardest time and suffered everything: o. D. Kameneva's prison years. Bulletin of perm university. History 61, 128–136.

[18] Hashim, R., Cooper, S., Salleh, N.A., Nawi, M.N.M., 2022. The influence of regulatory pressure in shaping construction firms' decision to adopt green innovation. J. Adv. Res. Appl. Sci. Eng. Technol. https://doi.org/10.37934/araset.28.2.301310.

[19] Hu, Y., Shu, H., 2023. Synergetic mechanism of agricultural logistics ecosphere –the case study based on Jiangxi Taoxin. Nankai Bus. Rev. Int. 14, 272–294. https://doi.org/ 10.1108/NBRI-10-2021-0071.

[20] Indrayana, D.V., Pribadi, K.S, 2023. A proposed framework of measuring maturity of safety leadership in construction. In: Proceedings of the AIP Conference, 2599. American Institute of Physics Inc.: Institut Teknologi Bandung, Bandung, 40132, Indonesia. B., H., null, M., E., H., B., A., B.O., A., M.F., A., A.M., Q., EdsVol.

[21] Jiang, S., Wei, X., Jia, J., Ma, G., 2022. Toward sustaining the development of green residential buildings in China: a tripartite evolutionary game analysis. Build.

[22] Environ. 223 https://doi.org/10.1016/j.buildenv.2022.109466.

[23] Karayel, G.K., Javani, N., Dincer, I., 2023. Hydropower for green hydrogen production in Turkey. Int. J. Hydrog. Energy 48, 22806–22817. https://doi.org/10.1016/j. ijhydene.2022.04.084.

[24] Khahro, S.H., Shaikh, H.H., Zainun, N.Y., Sultan, B., Khahro, Q.H., 2023. Delay in decision-making affecting construction projects: a sustainable decision-making model for mega projects. Sustainability 15. https://doi.org/10.3390/su15075872. Khan, M., Shafiq, N., Waqar, A., Radu, D., Cismaş, C., Imran, M., Almujibah, H., Benjeddou, O., 2023. Effects of jute fiber on fresh and hardened characteristics of concrete with environmental assessment. Buildings 13, 1691. https://doi.org/ 10.3390/buildings13071691.

[25] Kuzucuoglu, D., Koc, K., Kazar, G., Tokdemir, O.B., 2023. Prioritization of risk mitigation ˇ strategies for contact with sharp object accidents using hybrid bow-tie approach. Saf. Sci. 166 https://doi.org/10.1016/j.ssci.2023.106248.

[26] Parekh, Ruchit. "Trends and challenges in LEED v4. 1 healthcare certification: A comprehensive analysis of US hospital scores in 2024." World Journal of Advanced Engineering Technology and Sciences 12.2 (2024): 726-740.

[27] Lühr, G.J., Wagner, R.F., Radujkovi´c, M., 2023. The influence of leadership on the projectification of the public construction sector in Germany. Buildings 13. https:// doi.org/10.3390/buildings13061506.

[28] Larsen, E., Brandenburg, R., 2023. Navigating the neo-academy: experiences of liminality and identity construction among early career researchers at one Australian regional university. Aust. Educ. Res. 50, 1069–1087. https://doi.org/10.1007/ s13384-022-00544-1.

[29] Latiffi, A.A., Zulkiffli, N.A., 2022. Understanding the relationship of leadership skills in the pre-construction phase with the success of sustainable construction projects.

[30] Parekh, Ruchit. Constructing Wellness: Harnessing AI for a Sustainable and Healthy Future. Elsevier, 2024.

[31] Lee, J.H., Ashuri, B., 2023. Project chief engineer: an industry review of a new position on design-build teams for major transportation projects. J. Leg. Aff. Disput. Resolut. Eng. Constr. 15 https://doi.org/10.1061/JLADAH.LADR-954.

[32] Li, M., Wu, Y., Lv, F., 2023. Influencing factors of ideological and political construction work based on VSBPC model. Appl. Math. Nonlinear Sci. https://doi.org/10.2478/ amns.2023.1.00321.

[33] Ma, S., Huang, H., Tian, F., Duan, Z., Gong, J., Zhang, J., 2023. Investigation of dynamic characteristics and cumulative plastic strain prediction model of clay-fouled round gravel under cyclic subway loading. Soil Dyn. Earthq. Eng. 174 https://doi.org/ 10.1016/j.soildyn.2023.108173.

[34] Madson, K., Franz, B., Leicht, R., Nelson, J., 2022. Evaluating the sustainability of new construction projects over time by examining the evolution of the LEED rating system. Sustainability 14. https://doi.org/10.3390/su142215422.

[35] Maqbool, R., Thompson, C., Ashfaq, S., 2023. LEED and BREEAM green building certification systems as possible game changers in attaining low-cost energy-efficient urban housing projects. J. Urban Plan. Dev. 149 https://doi.org/10.1061/JUPDDM. UPENG-4292.

[36] Mergos, P.E., 2023. Sustainable and resilient seismic design of reinforced concrete frames with rocking isolation on spread footings. Eng. Struct. 292 https://doi.org/10.1016/ j.engstruct.2023.116605.

[37] Mohamed, H.A.E., Eltohamy, A.I., 2022. Critical success factors for competitiveness of Egyptian construction companies. Sustainability 14. https://doi.org/10.3390/ su141710460.

[38] Parekh, Ruchit. Blueprint for Sustainability: LEED Implementation in Commercial Projects. Elsevier, 2024.

[39] Othman, A.A.E., Elwazer, M.N., 2023. A talent management based framework for developing sustainable quality of work life in architectural design firms in Egypt. Int. J. Archit. Res. Archnet IJAR 17, 243–266. https://doi.org/10.1108/ARCH-12-2021- 0365.

[40] Oyewobi, L.O., Jimoh, R.A., 2022. Barriers to adoption of sustainable procurement in the Nigerian public construction sector. Sustainability. https://doi.org/10.3390/ su142214832.

[41] Phinias, R.N., 2023. Benefits and challenges relating to the implementation of health and safety leading indicators in the construction industry: a systematic review. Saf. Sci.

[42] 163 https://doi.org/10.1016/j.ssci.2023.106131.

[43] Quyen, B.T., Huong, N.T.M., Han, D.T., Tung, P.H., Thu, N.T.X., Dung, T.P., 2023. Factors affecting Gen Z trend of ‘standard working’ in Vietnam. Rev. Gest. Soc. e Ambient. 17 https://doi.org/10.24857/rgsa.v17n5-024.

[44] Ramis, M.S., Langoni, A.M., Pozzobon, F.B., Risuenho, F.M., Rego, F.C., Vitiello, R.P., 2023. Integrity management: a basic pilar of efficiency improvement program for offshore production unit. In: Proceedings of the Annual Offshore Technology Conference; Offshore Technology Conference: PETROBRAS. Vol. 2023-May.

[45] Samuelsson, A.U., Larsman, P., Grill, M., 2023. For the sake of safety: a time-lagged study investigating the relationships between perceived leadership behaviors and employee safety behaviors. Saf. Sci. 166 https://doi.org/10.1016/j.

[46] ssci.2023.106245.

[47] Tran, K.D.P., Thuy Vo, T.N., Tram Thai, N.B., 2023. The effect of innovation on competitive advantage and SMEs performance in vietnam: the moderating role of customer orientation. Int. J. Innov. Sci. https://doi.org/10.1108/IJIS-08-2022-0161.

[48] Turnbull, B., Gordon, S.F., Fuentes-Balderrama, J., Ojeda-García, A., Cruz del Castillo, C., 2023. Resilience is not free: the undeserved failure of the urban poor in Mexico.

[49] Advers. Resil. Sci. 4, 319–333. https://doi.org/10.1007/s42844-023-00099-9.

[50] Waqar, A., Ahmed, W., 2023. Reimagining construction safety: unveiling the impact of building information modeling (BIM) implementation. Saf. Extreme Environ. https://doi.org/10.1007/s42797-023-00086-4.

[51] Waqar, A., Khan, M., 2023. Assessment of challenges to the adoption of IOT for the safety management of small construction projects in Malaysia: structural equation modeling approach. Appl. Sci. 13 https://doi.org/10.3390/app13053340.

[52] Waqar, A.; Othman, I. Challenges to the implementation of BIM for the risk management of oil and gas construction projects : structural equation modeling approach sustainability challenges to the implementation of BIM for the risk management of oil and gas construction project. 2023, 10.3390/su15108019.

[53] Waqar, A.; Othman, I.; Shafiq, N.; Altan, H. Modeling the effect of overcoming the barriers to passive design implementation on project sustainability building success : a structural equation modeling perspective sustainability modeling the effect of overcoming the barriers to passive design impleme. 2023.

[54] Waqar, A., Othman, I., Radu, D., Ali, Z., Almujibah, H., Hadzima-Nyarko, M., Khan, M.B., 2023. Modeling the relation between building information modeling and the success of construction projects: a structural-equation-modeling approach. Appl. Sci. 13 https://doi.org/10.3390/app13159018, 9018.

[55] Waqar, A., Othman, I., Shafiq, N., Mansoor, M.S., 2023a. Applications of AI in oil and gas projects towards sustainable development: a systematic literature review. Artif.

[56] Intell. Rev. 56, 12771–12798. https://doi.org/10.1007/s10462-023-10467-7.

[57] Waqar, A., Khan, M.B., Shafiq, N., Skrzypkowski, K., Zagorski, K., Zag´ orska, A., 2023b. ´ Assessment of challenges to the adoption of IOT for the safety management of small construction projects in malaysia: structural equation modeling approach. Appl. Sci.

[58] 13, 3340. https://doi.org/10.3390/app13053340.

[59] Waqar, A., Qureshi, A.H., Alaloul, W.S., 2023c. Barriers to building information modeling (BIM) deployment in small construction projects: Malaysian Construction Industry. Sustainability 15, 2477. https://doi.org/10.3390/su15032477.

[60] Waqar, A., Hannan Qureshi, A., Othman, I., Saad, N., Azab, M., 2023d. Exploration of challenges to deployment of blockchain in small construction projects. Ain Shams Eng. J., 102362 https://doi.org/10.1016/j.asej.2023.102362.

[61] Waqar, A., Othman, I., Almujibah, H., Khan, M.B., Alotaibi, S., Elhassan, A.A.M., 2023e. Factors influencing adoption of digital twin advanced technologies for smart city development: evidence from Malaysia. Buildings 13, 775. https://doi.org/10.3390/ buildings13030775.

[62] Waqar, A., Othman, I., Pomares, J.C., 2023f. Impact of 3D printing on the overall project success of residential construction projects using structural equation modelling. Int. J. Environ. Res. Public Health. https://doi.org/10.3390/ijerph20053800.

[63] Waqar, A., Othman, I., Shafiq, N., Altan, H., Ozarisoy, B., 2023h. Modeling the effect of overcoming the barriers to passive design implementation on project sustainability building success: a structural equation modeling perspective. Sustainability 15, 8954. https://doi.org/10.3390/su15118954.

[64] Waqar, A., Skrzypkowski, K., Almujibah, H., Zagorski, K., Khan, M.B., Zag´ orska, A., ´ Benjeddou, O., 2023i. Success of implementing cloud computing for smart development in small construction projects. Appl. Sci. 13, 5713. https://doi.org/ 10.3390/app13095713.

[65] Waqar, A., Othman, I., Hayat, S., Radu, D., Khan, M.B., Galatanu, T.F., Almujibah, H.R., Hadzima-Nyarko, M., Benjeddou, O., 2023j. Building information modeling–empowering construction projects with end-to-end life cycle management. Buildings 13.

[66] Waqar, A., Othman, I., Pomares, J., 2023k. Impact of 3D printing on the overall project success of residential construction projects using structural equation modelling. Int. J. Environ. Res. Public Health 20, 3800. https://doi.org/10.3390/ijerph20053800.

[67] Yun, M., 2023. Instrumental leadership and creativity: cognitive mechanisms via problem-solving rumination and knowledge sharing with coworkers. Leadersh.

[68] Organ. Dev. J. 44, 543–563. https://doi.org/10.1108/LODJ-08-2022-0357.

[69] Zaman, U., Florez-Perez, L., Anjam, M., Ghani Khwaja, M., Ul-Huda, N., 2023. At the end of the world, turn left: examining toxic leadership, team silence and success in mega construction projects. Eng. Constr. Archit. Manag. 30, 2436–2462. https://doi.org/ 10.1108/ECAM-08-2021-0755.

[70] Zenteno, E., Sepúlveda, K., Johnson, K., Díaz, J.I., 2023. Women settlers in the reemergence and consolidation of the squatter land plots in Vina del Mar, Chile. Eure ˜ 49. https://doi.org/10.7764/eure.49.147.01.

[71] Zhang, D., Dong, H., 2023. Understanding arable land change patterns and driving forces in major grain-producing areas: a case study of Sichuan province using the PLUS model. Land 12. https://doi.org/10.3390/land12071443.