sustainability

MDPI

Article

Developing an Integrated Analytical Framework for Sustainability Assessment: Focusing on Selected Projects in Riyadh

Haitham Sadek Selim [1,*,†], Abdullah Abuzaid [2] and Mohammed Salah Mayhoub [3]

[1] Department of Architecture, College of Engineering and Information Technology, Onaizah Colleges, Qassim 56219, Saudi Arabia
[2] Architectural Engineering Department, College of Engineering, Imam Mohammad Ibn Saud Islamic University, Riyadh 11432, Saudi Arabia; aizaid@imamu.edu.sa
[3] Architecture Department, Faculty of Engineering, Al-Azhar University, Cairo 11651, Egypt; msm@azhar.edu.eg
* Correspondence: hmselim@oc.edu.sa or haitham.selim@gmail.com
† On Leave of Architecture Department, Faculty of Engineering, Al-Azhar University, Cairo 11651, Egypt.

Abstract: Riyadh, the capital of the Kingdom of Saudi Arabia, is now presenting itself as one of the most attractive capitals in the Middle East, with a number of ambitious expansion projects that aim to develop the city and align its urban development with the goals of Vision 2030. This urban renaissance requires researchers to adopt evaluation approaches (BSAMs) based on comprehensive sustainability criteria represented by environmental and cultural sustainability, community engagement, and economic feasibility. This research relies on the ETE methodology to determine evaluation criteria and their weights, which is a systematic and interactive method of prediction based on the opinion of a group of experts, or what is known as the Delphi method. Experts answered questionnaires to determine the weights of the criteria in three rounds where they received an anonymous summary of the experts' predictions from the previous round with the reasons they provided for their judgments. The responses were then analyzed to identify recurring and converging themes and contradictions using the top-of-priority similarity to ideal solution (TOPSIS) technique, thus deriving an integrated evaluation model. The model was applied to evaluate architectural practices in Riyadh through three major projects: the King Abdullah Petroleum Studies and Research Center, the King Abdullah Financial District, and the King Abdullah Financial District Metro Station. Data sources included comprehensive site visits, detailed project documentation, and expert evaluation through structured questionnaires to gain a realistic view of attitudes towards architectural needs and sustainability. This adds to the knowledge on how globalization interacts with the urban renewal landscape in Riyadh and encourages us to continue proposing effective evaluation models by drawing attention to the multidimensional nature of sustainability. This in turn points to the need for continuous re-evaluation of architectural activities in Riyadh through project evaluation results that attest to their compatibility with international standards and local cultural contexts. Overall, the proposed evaluation model has proven successful in testing projects at the local level by providing a sustainable framework. The results showed that projects adhere to varying levels of sustainability requirements, but, more importantly, these evaluation models were developed to rationalize accelerated construction processes.

Keywords: sustainability urban development analytical framework; urban connectivity-BSAMs-rapid urban

Citation: Selim, H.S.; Abuzaid, A.; Mayhoub, M.S. Developing an Integrated Analytical Framework for Sustainability Assessment: Focusing on Selected Projects in Riyadh. *Sustainability* **2024**, *16*, 10185. https://doi.org/10.3390/su162310185

Academic Editor: Claudia Casapulla

Received: 15 September 2024
Revised: 23 October 2024
Accepted: 28 October 2024
Published: 21 November 2024

1. Introduction

Construction processes indicate the occurrence of social development and its impact on people's quality of life [1]. It is a measure of the extended economic performance of

both developed and developing countries, with significant contributions to the GDP of these countries. The outputs resulting from this industry are "buildings", which are one of the most important necessities of life [2]. The rapid urban expansion witnessed by Riyadh provides a unique and representative example for studying global urban development aspects [3]. Nowadays, there are challenges facing contemporary architecture represented by spatial globalization. In rapidly developing places, there is a concern that the construction process risks creating a mere "copy" of one place in another—in other words, that cities become "copies" of other cities [4], with buildings moving from one context into another without considering their impact or adopting a sustainable approach to design. A recent literature review Frantzeskaki (2017) on "urban development" points to shifts towards sustainability adoption and an increasing focus on the urban context and examination of different dynamics in the sustainability transition [5].

Cities have increasingly been identified as particularly important places for sustainability transitions and related system innovations to emerge and unfold [6]. Sustainability assessment has been identified as one of the beneficial tools that exists, and it can be used in order to foster sustainable development, ranging from the design and construction right through to management stages [7,8]. Nowadays, many countries or researchers have developed related indicator frameworks to evaluate an individual building or entire cities [9], such as the Leadership in Energy and Environmental Design (LEED) from the United States [10].

Analyzing the current architectural environment in Riyadh through the lens of globalization reveals many complexities. Over the past decades, different architectural trends have been introduced, which, under different names and with similar contents, point to the same direction)modernity) in everything, including architecture. In most cases, they have focused on incorporating the principles, characteristics, and elements of sustainable design, but have suffered from a gap in the comprehensive evaluation approach [11].

While the application of global technologies and sustainability practices may be entirely beneficial, the overuse of architectural materials and features that are incompatible with the local context is becoming increasingly worrisome. This is an ongoing discourse that emphasizes the balance between global influence and local reality [12], thus placing at its heart the fundamental challenge of architecture as what works and what does not [13]. Indeed, the emerging focus on global architectural trends has led critics to assert that expansionist projects, such as these, have grossly neglected contextual issues of a local nature. This adoption of global architectural models reflects the quest for modernity in architecture, but when replicated on a large scale in many countries, it has led to this research interest in a comprehensive understanding of the contemporary architectural landscape in Riyadh in light of globalization from a sustainable perspective [14].

There is a lack of research on measuring the sustainability of urban development at the community level. This is generally performed in a subjective and one-sided manner when it comes to selecting and weighting indicators. Most studies on sustainability assessment take the perspective of consistency, with certification bodies, such as LEED or others, dealing only with energy consumption, ignoring the economic and cultural dimensions of sustainability [15,16].

Many studies [17] argue that some community-level indicator frameworks for measuring sustainable urban development, such as LEED-ND and BREEAM-Communities, also neglect to comprehensively analyze the social, economic and environmental aspects of sustainability. They exhibit ambiguity and shortcomings in weighting, scoring, or ranking systems. Furthermore, the number and type of indicators also differ significantly among these proposed indicator frameworks.

Too many indicators make data collection and assessment cumbersome [18], while a few indicators cannot provide full insight into any assessment.

The ongoing discourse on the balance between global influences and cultural authenticity underscores the inherent challenge in the architectural field of distinguishing what is appropriate and what is not. It is important to recognize that while the focus on

global architectural trends and expansion projects has gained attention, criticism has arisen regarding the neglect of local contextual issues [19,20].

From this standpoint, the importance and methods of assessing the sustainability of buildings (BSAM) are established to enable project stakeholders to understand the expected and actual sustainability performance of their buildings [21], but they are often applied in a technical and quantitative manner without considering other sustainability measures. Hence, the idea of research in an attempt to propose an integrated assessment model has emerged.

2. Method

The literature review is the first step needed to identify the most important sustainability indicators worldwide; then, these indicators will be refined and integrated to avoid duplication, and a model will be proposed that includes all environmental, cultural, and social criteria. These consist of the basic and sub-criteria under which the indicators fall. The current study relied on the expert judgment method to evaluate the proposed model and to assign weights to each indicator. This is a recognized and valid approach, especially when empirical data are limited or difficult. Examples of expert assessments, including weights, were collected from 11 out of 17 experts contacted in the fields of architecture and sustainability, urban renewal, and construction project management, and officials of some major projects in Riyadh. The study preferred participants with longer experience in the field of sustainable architecture and urban development, especially those who have worked in Riyadh or in a similar context. Studies emphasize expert background as one of the ways to secure data on the basic foundations of the subject [22]. In fact, the expert judgment framework builds on the sound foundations established by the literature by emphasizing the fact that expert judgment, where there is a lack of quantitative data, will yield crucial insights [23]. This research adopts the Delphi method, also known as the ETE [24] method (estimate–talk–estimate) [25], to determine the evaluation criteria and their weights, which is an interactive method of prediction based on the opinion of a group of experts. Experts answered questionnaires to determine the weights of the criteria in three rounds, where they received an anonymous summary of the experts' predictions from the previous round along with the reasons they provided for their judgments (see Figure 1).

Several studies have shown that 10–12 expert respondents are sufficient to confirm the validity of the results, as these types of studies do not rely on statistical inference [25–27]. The optimal weights for the main items derived from the survey data were then estimated using the best and worst case TOPSIS method. The results were reviewed with the expert respondents again in order to confirm the final weights [28]. Then, the study examined leading architectural practices in Riyadh by evaluating a model that analyzes three major projects: the King Abdullah Petroleum Studies and Research Center, the King Abdullah Financial District, and the King Abdullah Financial District Metro Station. Data sources included comprehensive site visits and detailed project documentation. These projects were subjected to a comprehensive analysis according to the model that was constructed.

- Literature review

Urban growth in new urban communities requires certain conditions: to achieve comprehensive gains in sustainable development, a balance must be struck in progress across societal, environmental and economic dimensions. This balance will bear fruit through an ecologically healthy environment, harmonious social coexistence, and long-term economic growth [29].

Previous research on the issue of sustainable urban development in urban communities includes disciplines related to the evaluation of community conservation initiatives and case studies of sustainable communities [30]. Until recently, this movement started to take hold only in developed countries, such as the United Kingdom, the United States, and Japan [31].

Furthermore, the New European Bauhaus initiative [32], introduced in 2020 by the European Union, aims to accelerate the green transition across sectors of the economy, society, and everyday life. The solutions being put across entail rebuilding cities, retrofitting buildings to ensure affordable housing, and construction in line with carbon neutrality [33].

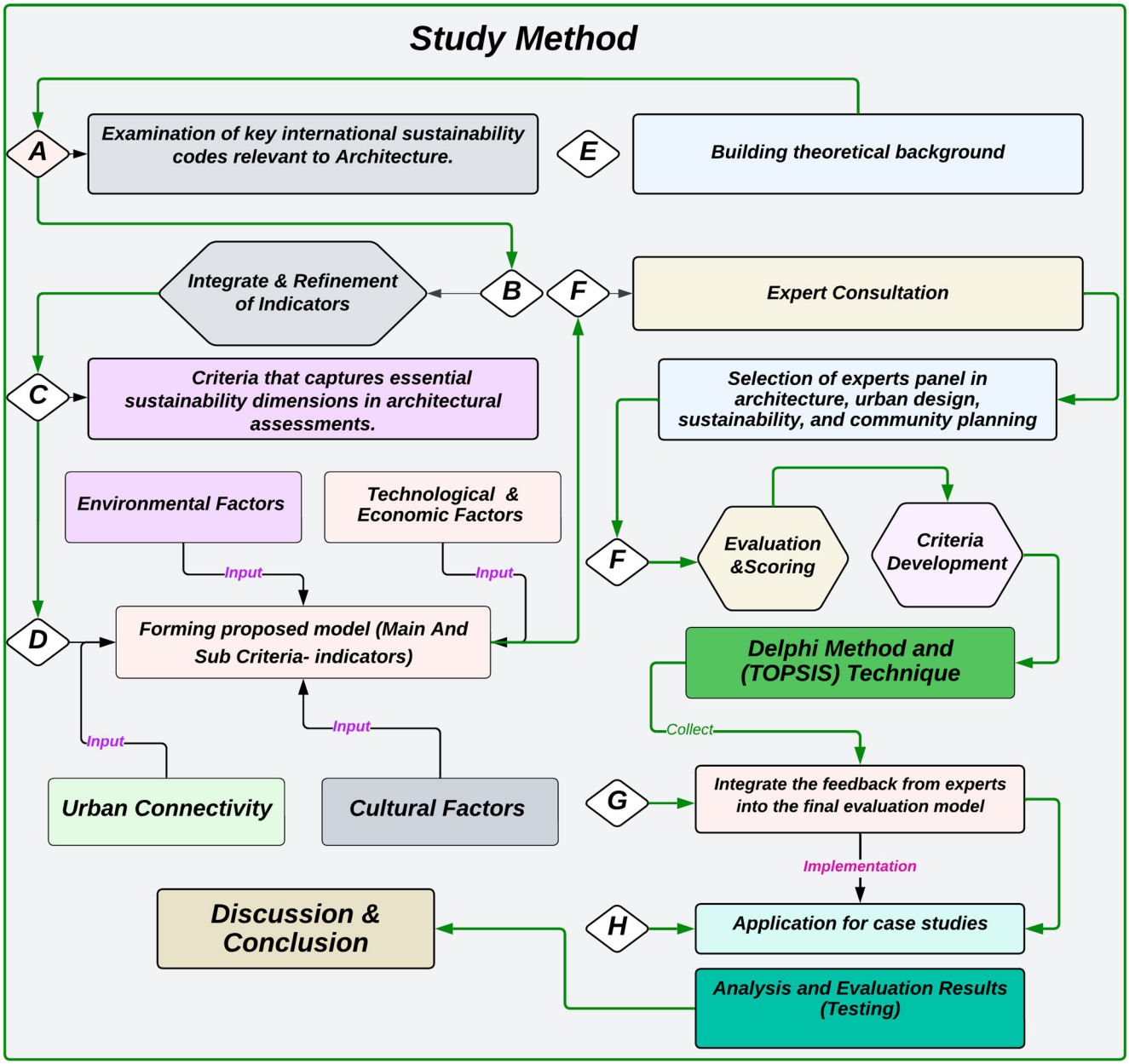


Figure 1. Study method and procedures.

Appropriate indicators can be applied, above all, within a comprehensive framework which allows for the evaluation of sustainable practices [34]. The DSR model, proposed by UNCED, chose 58 indicators that evaluate 22 countries and regions [35]. Case studies regarding Vietnam, Mexico City, and a host of projects dealing with community level urban development projects, such as Masdar Eco-City in the UAE, also show that the assessment toolsets utilized within a specific economic, social, and cultural background would greatly enhance development functions in terms of sustainability [36]. However, the comprehensive assessment for most of these projects is currently missing many aspects, including the influence of location. For instance, Egyptian urban development projects illustrate that developments can place pressures on surrounding older cities due to a lack of facilities and services [37]. There is even quite a marked disparity between concept and reality in some European cities, despite the successes of a sustainable approach to urban development [34].

3. Building the Proposed Sustainability Model

A. Classifying the Most Important Sustainability Indicators Globally

Several major bodies play a significant role in advocating for environmental standards and certifications in sustainable architecture and building practices. Energy Star and the International Energy Agency, in particular, are vital in measuring energy efficiency based on the amount of energy used per square foot [38]. The World Carbon Project and World Resources Institute are involved in measuring greenhouse gas emissions from buildings [39]. The AWS Water Stewardship Alliance and the Global Water Partnership provide guidelines for efficient water use to address water conservation [40]. In terms of indoor air quality, the WELL Building Standard and the WELL International Building Institute review indoor pollutant levels, such as volatile organic compounds and carbon dioxide [41]. These sustainable materials have ratings from entities, such as LEED, for the use of recycled or sustainably sourced materials, and the Cradle to Cradle Certified product standard. Similarly, waste management practices are supported by LEED and ZWIA [42]. Biodiversity in Good Company and the International Union for Conservation of Nature monitor biodiversity impacts [43]. The RE100 initiative and the World Renewable Energy Council call for a commitment to 100% renewable electricity among participating companies [44]. Finally, site sustainability and urban development impact can be assessed through certifications, such as LEED-ND and BREEAM Communities [45].

ASHRAE [46] standards address thermal comfort, while International Organization for Standardization (ISO) [47] guides building lifecycle assessments. Similarly, the USGBC regulates the LEED [48] certification process, which has 60 credit points on different sustainability measures. The criteria provided assess buildings on natural light and acoustic performance, with LEED credit awarded for daylight access and sound insulation. ILFI [49] also sets very stringent standards through its Living Building Challenge; under the LBC, buildings must meet 20 indictors to achieve certification. For example, the CASBEE framework—particularly its city-focused iteration—allows for urban sustainability assessments, while BREEAM for Communities sets sustainability standards for community development. The German Urban Building Association evaluates new urban areas, including the DGNB [50], and valuates new urban districts with the DGNB-NS certification. Additionally, the Assessment Standard of Green Eco-district (ASGE) [27] facilitates local eco-district evaluations [51]. For example, UN-Habitat [52] defines social indicators, such as social equality in housing. In contrast, community participation is promoted through local development organizations. Health and safety compliance in building design is regulated by the Occupational Safety and Health Administration in cooperation with ISO 45001 [53]. The economic impacts of the Global Reporting Initiative for construction projects under the Global Reporting Initiative are aligned with the targets set by the UN Sustainable Development Goals [54]. The International Labor Organization reports on indicators related to job creation. It also allows for the preservation of community culture through local organizations and is a way to ensure access to cultural facilities through local government agencies. IDEA [55] also advocates for civic engagement in governance issues to ensure that communities are involved and well informed about sustainable development practices. Table 1 summarizes the most important global codes and standards for achieving sustainability.

While the above sustainability indicators available so far in architecture and construction practices provide constructive assessments, most fall short of representing a comprehensive assessment model for the environmental, economic, social, and cultural dimensions. Inclusion of other meaningful indicators of economic viability, such as return on investment and long-term cost savings, would also add more insight into financial sustainability. Social equity, access, and community well-being dimensions have to be incorporated if the process is meaningfully to contribute to benefit all residents. Community engagement in cultural sustainability indicators would also ensure the preservation of local heritage and cultural identities. Only by applying all of those indicators within one assessment model will stakeholders understand what sustainability truly means and

make better decisions to accomplish high-quality buildings that serve both current and future generations.

Table 1. Overview of sustainability indicators for architecture and building practices.

Indicator	What It Measures	Certification/Global Entity	Number of Indicators
Energy efficiency	Amount of energy consumed per square foot	Energy Star, International Energy Agency (IEA)	Varies by building type and rating
Greenhouse gas emissions	Total carbon emissions produced by the building	Global Carbon Project, World Resources Institute (WRI)	Varies; can use specific carbon calculators
Water use and conservation	Total water consumption and efficiency of water use	Alliance for Water Stewardship (AWS), Global Water Partnership	Varies; often project-specific
Indoor air quality (IAQ)	Levels of indoor air pollutants, like VOCs and CO_2	WELL Building Standard, International WELL Building Institute	12 features under the WELL standard
Sustainable materials	Use of recycled, renewable, or sustainably sourced materials	LEED (Leadership in Energy and Environmental Design), Cradle to Cradle Certified	14 credits in LEED
Waste management and diversion	Percentage of construction and demolition waste diverted from landfills	Zero Waste International Alliance (ZWIA), LEED	2 credits in LEED
Biodiversity impact	Impact of building on local flora and fauna	Biodiversity in Good Company, IUCN (International Union for Conservation of Nature)	Varies; often project-specific
Renewable energy use	Percentage of energy derived from renewable sources	RE100, Global Renewable Energy Council	Commitment to 100% renewable electricity by participants; no fixed number of indicators
Site sustainability	Impact of development on surrounding ecosystems	LEED, BREEAM (Building Research Establishment Environmental Assessment Method), LEED-ND, BREEAM Communities	10 credits in LEED for site selection
Thermal comfort	Indoor temperature ranges and occupant comfort levels	ASHRAE Standards, WELL Building Standard	ASHRAE has multiple standards; WELL has specific features
Building lifecycle Assessment	Environmental impact across the building's entire lifecycle	ISO 14040/14044 (Life Cycle Assessment Standards) [47,56]	No fixed number; project-specific
LEED certification	Overall sustainability performance of the building	U.S. Green Building Council (USGBC)	63 credits in LEED v4
Natural lighting	Amount and quality of natural light in the building	LEED, WELL Building Standard	2 credits in LEED for Daylight
Acoustic performance	Sound insulation and overall acoustic comfort	ISO 16283 (Acoustics in Buildings), LEED [57]	2 credits in LEED for acoustic performance
Living building challenge (LBC)	Certification for buildings that are self-sufficient and sustainable	International Living Future Institute (ILFI)	20 performance standards in the LBC
CASBEE for cities (CASBEE-City)	Comprehensive assessment of urban sustainability	CASBEE (Construction and Sustainability for Environmentally Efficient Buildings)	Varies; typically has multiple criteria
BREEAM for communities	Sustainable planning and development for communities	BREEAM	Varies; sets out key objectives and criteria
(DGNB-NS)	Evaluation of new urban districts for sustainability	Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB)	Varies; typically includes several assessment criteria
Assessment Standard of Green Eco-district (ASGE)	Framework for evaluating eco-districts	Various local authorities and organizations	Varies; specific to local implementations
Social equity in housing	Accessibility and affordability of housing options	UN-Habitat	Varies; often project-specific
Community engagement	Involvement of residents in development decisions	Community development organizations (no specific global entity)	No fixed number; project-specific
Health and safety standards	Compliance with health and safety regulations	OSHA (Occupational Safety and Health Administration), ISO 45001	No fixed number; compliance with specific regulations

Table 1. *Cont.*

Indicator	What It Measures	Certification/Global Entity	Number of Indicators
Economic impact	Impact of the building on local economies and job creation	Global Reporting Initiative (GRI), UN Sustainable Development Goals (SDGs)	Varies; project-specific
Job creation	Number of jobs created through construction and operation	International Labour Organization (ILO)	No fixed number; project-specific
Community culture preservation	Maintenance and promotion of local cultural practices	Local community organizations (no specific global entity)	No fixed number; project-specific
Access to cultural amenities	Availability of arts, entertainment, and recreational facilities	Local government agencies (no specific global entity)	No fixed number; project-specific
Civic participation	Level of public participation in governance	International Institute for Democracy and Electoral Assistance (IDEA)	No fixed number; project-specific

4. Process of Selecting Suitable Indicators for the Local Context

The Delphi method [58] was used in collaboration with a multidisciplinary team of experts, namely 11 expert team members in the field of sustainable design and urban studies, as well as experts working on key projects in Riyadh, to build and enhance these indicators. We commenced by defining the purpose of our research and its importance in terms of architectural sustainability in all of its comprehensive dimensions through in-person meetings and using Zoom technologies Version 6.1.1 (46889).

A set of straightforward and concise questions was constructed in order to gauge the opinions of the experts on the various indicators of sustainability. In the first round, comments with regard to the relevance and feasibility of the indicators were to be made by the experts. The responses were then analyzed to identify recurring and converging themes and contradictions using the technique for order of preference by similarity to ideal solution (TOPSIS) [59]. After two rounds, the development of the assessment criteria was performed to provide an orderly procedure to determine the effective and efficient impacts that different projects have, considering multidimensional criteria varying by their sub-criteria and weight. This comprehensive framework evaluates architectural contributions in key areas of high importance, such as sustainability [60], economic integration, cultural value, community integration, and urban connectivity. We applied these filtered indicators to the three most prominent projects in Riyadh and followed the impact that these would have on sustainability outcomes across time. In this way, the Delphi method and TOPSIS technique have allowed for structured and meaningful collaboration, with useful insight into the advance of sustainability in its comprehensive meaning (Figure 2). Accordingly, there were comments on the evaluation model according to sets of basic criteria. The main environmental criterion was sustainable design [61], of which aspects are included at various stages of architectural projects by in order to meet the requirements for LEED certification, as well as for the verification of the efficiency of advanced technologies and a design feature assessment that tackle the environmental criterion [62]. The LEED compliance review upholds the importance of recognized standards for sustainability and, therefore, reflects a project's commitment to energy efficiency and care for the environment.

Critical evaluation of advanced technologies is important, since high scores under this category reveal their relevance to enhancing the sustainability of the built environment. Furthermore, creative solutions for energy consumption reduction and prioritizing sustainability give full support to achieving sustainability goals in an architectural design. However, the sub-criterion was low for the selection of materials, which might imply difficulties in quantifying sustainability in material selections or a tendency towards greater prioritization in operational aspects over the consideration of materials. The framework also focuses on the strategy of conserving water and improving indoor environmental quality. This is an indication of a holistic approach that considers the indoor and outdoor environmental impacts, according to Kibert 2012 [60].

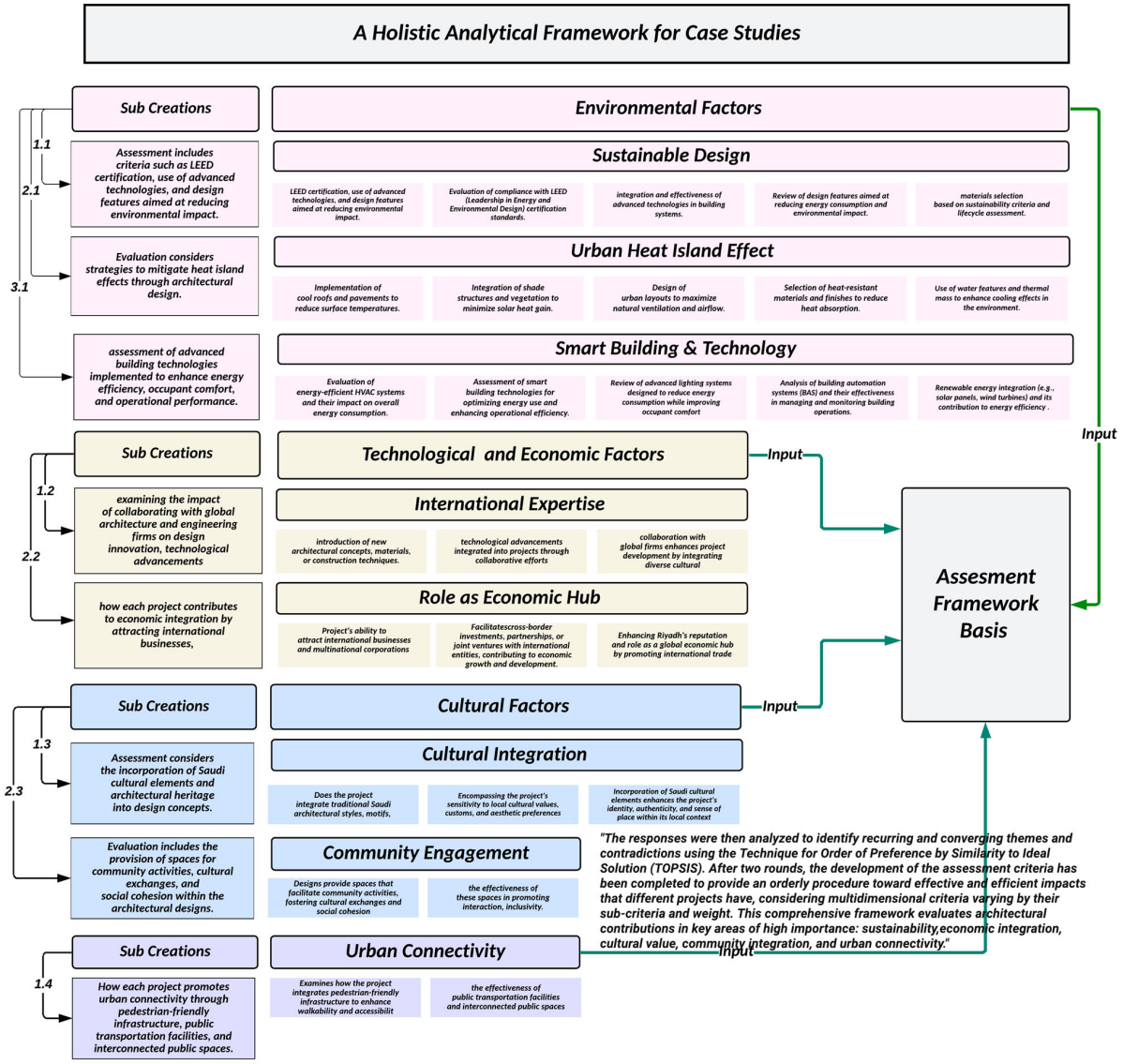


Figure 2. The core criteria and indicators sets after their integration and refinement.

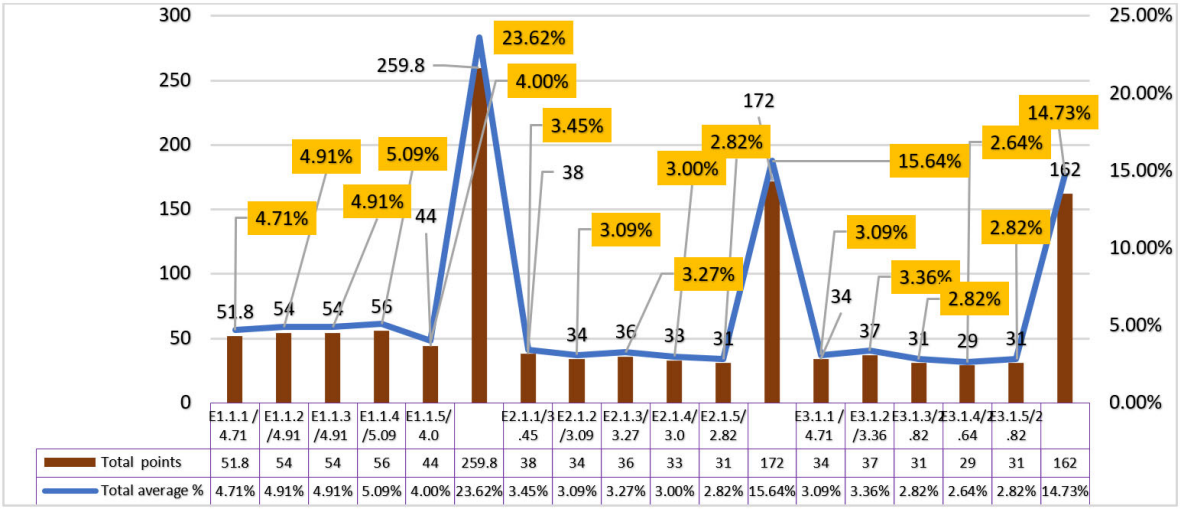
5. Proposed Model According to Expert Evaluation

According to the criteria and weights determined by the experts and according to the following tables, this research determined the presence of four main criteria: environmental (53.99%), technological and economic (24.36%), cultural (18.48%), and urban connectivity (3.17%). The environmental criterion is dominant, reflecting its decisive contribution to any form of sustainability assessment; it is supported by three sub-criteria and 15 indicators in total, as in Table 2. As weighted by the experts, Table 2 shows the evaluation of the environmental criterion in three sub-criteria, namely sustainable design, the urban heat island effect, and smart building technology, with the overall score of each representing its overall contribution to environmental sustainability. The highest score by far was in the sustainable design category, 1.1, which ranged from 4.00% to 5.09%, with a total score of 23.62 out of 100. The criterion with the highest average percentage in the same category was E1.1.4 (design features aimed at reducing energy consumption), with an average percentage of 5.09%, drawing significant attention to the design feature with the lowest environmental impact. In contrast, this urban heat island effect category scored significantly lower at 2.1, with an overall score of 15.64 out of 100 and individual averages peaking at just 3.45%. The conclusion here is that relatively little attention has been paid to strategies aimed at mitigating heat islands, such as the use of cool roofs or the incorporation of

shading structures. The lowest score for water feature implementation was 2.82% for E2.1.5, indicating significant scope for innovative design to improve the local climate. Finally, the lowest overall score was for the smart building technology sub-criterion at 3.1, with a total of just 14.73 out of a possible 100, indicating that advanced building technologies to enhance energy efficiency and occupant comfort were not highly rated. The average score in this group is highest at 3.36% for smart technologies, indicating a fair level of awareness regarding the technology and a little of its potential, but also indicating significant scope for improvement in terms of actually leveraging these technologies to achieve sustainability goals, as in Figure 3. Overall, this table represents the interest of organizations in sustainable design elements with a strong push to increase awareness and implementation strategies related to the urban heat island effect and smart building technology needed to create a more integrated approach to environmental sustainability. The cultural criterion had two sub-criteria and six indicators with a weight of 18.48%.

Table 2. Main criteria (assessing the environmental criterion).

Indicators	**Sub-criterion 1.1—Sustainable Design (assessment includes criteria, such as LEED certification, use of advanced technologies, and design features aimed at reducing environmental impact). Total score 23.62 of 100.**	**Total Average %**	**Code**
1.1.1	Assessment includes criteria, such as LEED certification, use of advanced technologies, and design features aimed at reducing environmental impact.	4.71%	E1.1.1/4.71
1.1.2	Evaluation of compliance with LEED (Leadership in Energy and Environmental Design) certification standards.	4.91%	E1.1.2/4.91
1.1.3	Assessment of the integration and effectiveness of advanced technologies in building systems.	4.91%	E1.1.3/4.91
1.1.4	Review of design features aimed at reducing energy consumption and environmental impact.	5.09%	E1.1.4/5.09
1.1.5	Analysis of materials selection based on sustainability criteria and lifecycle assessment.	4.00%	E1.1.5/4.0
Indicators	**Sub-criterion 2.1—Urban Heat Island Effect (evaluation considers strategies to mitigate heat island effects through architectural design). Total score 15.64 of 100.**	**Total Average %**	**Code**
2.1.1	Implementation of cool roofs and pavements to reduce surface temperatures.	3.45%	E2.1.1/3.45
2.1.2	Integration of shade structures and vegetation to minimize solar heat gain.	3.09%	E2.1.2/3.09
2.1.3	Design of urban layouts to maximize natural ventilation and airflow.	3.27%	E2.1.3/3.27
2.1.4	Selection of heat-resistant materials and finishes to reduce heat absorption.	3.00%	E2.1.4/3.0
2.1.5	Use of water features and thermal mass to enhance cooling effects in the environment.	2.82%	E2.1.5/2.82
Indicators	**Sub-criterion 3.1—Smart Building Technology (includes assessment of advanced building technologies implemented to enhance energy efficiency, occupant comfort, and operational performance). Total 14.73 of 100.**	**Total Average %**	**Code**
3.1.1	Evaluation of energy-efficient HVAC systems and their impact on overall energy consumption.	3.09%	E1.11/4.71
3.1.2	Assessment of smart building technologies for optimizing energy use and enhancing operational efficiency.	3.36%	E3.12/3.36
3.1.3	Review of advanced lighting systems designed to reduce energy consumption while improving occupant comfort.	2.82%	E3.13/2.82
3.1.4	Analysis of building automation systems (BAS) and their effectiveness in managing and monitoring building operations.	2.64%	E3.4/2.64
3.1.5	Examination of renewable energy integration (e.g., solar panels, wind turbines) and its contribution to energy efficiency and sustainability goals.	2.82%	E3.5/2.82



Total points	51.8	54	54	56	44	259.8	38	34	36	33	31	172	34	37	31	29	31	162
Total average %	4.71%	4.91%	4.91%	5.09%	4.00%	23.62%	3.45%	3.09%	3.27%	3.00%	2.82%	15.64%	3.09%	3.36%	2.82%	2.64%	2.82%	14.73%

Figure 3. Diagram displaying measurements and results of environmental standards and sub-criteria.

The technological and economic criterion came in second place, with two sub-criteria and six indicators, as in Table 3. The technological and economic criterion was assessed through two main sub-criteria, namely international experience and role as an economic hub, whose overall ratings indicate the relative contributions to project success. The international experience group, which received an overall rating of 12.54 out of 100, indicates that partnerships with international architectural firms are expected to be favorable, as evidenced by the relative range from an average of 4.07% to 4.27%.

Table 3. Technological and economic criterion.

Indicators	**Sub-criterion 1.2—International Expertise (impact of collaborating with global architecture firms on design innovation, technological advancements, and the integration of diverse perspectives into project development). Total 12.54 of 100.**	**Total Average %**	**Code**
1.2.1	Assessment of design innovation fostered through collaboration, including the introduction of new architectural concepts, materials, or construction techniques.	4.27%	T1.2.1/4.07
1.2.2	Evaluation of technological advancements integrated into projects through collaborative efforts, such as the adoption of advanced building systems, sustainable technologies, or digital design tools.	4.09%	T1.2./4.09
1.2.3	Analysis of how collaboration with global firms enhances project development by integrating diverse cultural, environmental, and technical perspectives, contributing to holistic and innovative design solutions.	4.18%	T2.3/4.18
Indicators	**Sub-criterion 2.2—Role as Economic Hub (project contributes to economic integration by attracting international businesses, fostering cross-border investments, and enhancing the city's local role as a global economic hub). Total 11.82 of 100.**	**Total Average %**	**Code**
2.2.1	Assessment of the project's ability to attract international businesses and multinational corporations to establish operations or headquarters in Riyadh.	4.09%	T2.2.1/4.09
2.2.2	Assessment of the project's ability to attract international businesses and multinational corporations to establish operations or headquarters in Riyadh.	4.18%	T2.2.2/4.18
2.2.3	Analysis of the project's impact on enhancing Riyadh's reputation and role as a global economic hub by promoting international trade, commerce, and investment opportunities in the region.	3.55%	T2.2.3/3.55

Innovation in design through collaboration ranked highest at 4.27%, indicating the level of international partnerships that may be important in achieving innovative and im-

proved architectural practices. For example, the assessment of technological development due to collaboration was rated at 4.09%, which was an indication that such collaborations have introduced the adoption of sustainable technologies and innovative construction techniques that significantly enhance the quality of projects. The overall average of 4.18% that came from the analysis of multidisciplinary perspectives that influence integrated design solutions (T1.2.3) supports the fact that diverse technical inputs are important in enhancing project creation, as shown in Figure 4.

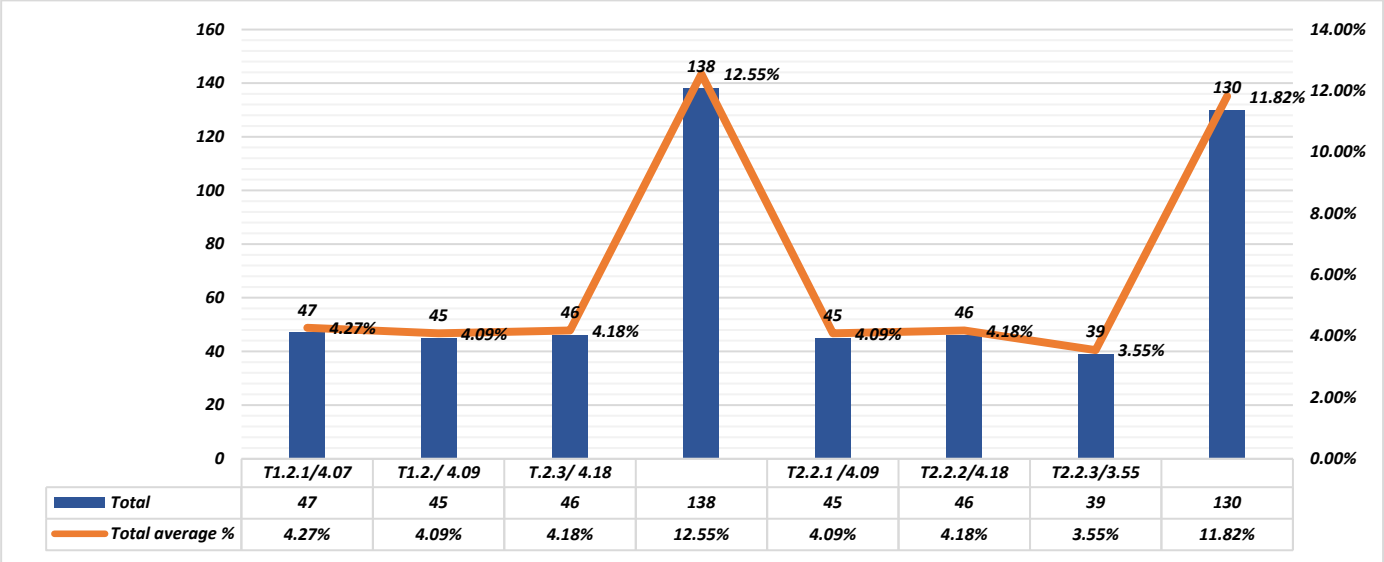


Figure 4. Diagram displaying measurements and results of the technological and economic criterion and sub-criteria.

On the other hand, the sub-criterion "Role as an Economic Hub", which reflects the project's impact on the economic landscape in Riyadh, totaled 11.82 out of 100. The potential to attract multinational companies from this project (T2.2.1 and T2.2.2) reflects a competitive impact in the region, with these aspects scoring 4.09% and 4.18%, respectively.

The cultural criterion has two sub-criteria and six indicators, with a weight of 18.48%, as in Table 4. Two sub-criteria, namely cultural integration and community engagement, will determine the role of architectural design in relation to the culture of the population and community dynamics. The cultural integration category provides an average level of focus overall, with a total score of 10.64 out of 100 in terms of incorporating Saudi cultural elements and architectural heritage into the design concept. The highest score within this sub-criteria represents the incorporation of traditional Saudi architectural style, C1.3.1, at 3.91%, which, while appreciating traditional aesthetics, still leaves significant room for further improvement in the full integration of local architecture. This is followed by the assessment of the project's sensitivity to local cultural values and aesthetic preferences, C1.3.2, at 3.64%, reflecting a significant approach to contextual design. However, the score of 2.91% is relatively lower, confirming the low rating of these criteria from the experts' perspective. In contrast, the sub-criterion for community engagement has a total score of 7.84 out of 100, highlighting the importance of social cohesion and cultural exchange. The highest score in this category was given to the provision of spaces that allow for community activities, which was 4.64% in criterion 2.3.1. While the assessment of the effectiveness of these spaces in promoting inclusion and community engagement was 4.00% in C2.3.2, it can be said that while there are positive examples of inclusive community space, further improvements are still needed in terms of the real needs of inclusive diversity within the community, as shown in Figure 5.

Table 4. Cultural criterion.

Indicators	**Sub-criterion 1.3—Cultural Integration (assessment considers the incorporation of Saudi cultural elements and architectural heritage into design concepts). Total 10.64 of 100.**	Total Average %	Code
1.3.1	Does the project integrate traditional Saudi architectural styles, motifs, or materials into its design?	3.91%	C1.3.1/3.91
1.3.2	Encompassing the project's sensitivity to local cultural values, customs, and aesthetic preferences.	3.64%	C1.3.2/3.64
1.3.3	Examining how the incorporation of Saudi cultural elements enhances the project's identity, authenticity, and sense of place within its local context.	2.91%	C1.3.3/2.91
Indicators	**Sub-criterion 2.3—Community Engagement (provision of spaces for community activities, cultural exchanges, and social cohesion within the architecture). Total 7.84 of 100.**	**Total Average %**	**Code**
2.3.1	Evaluation considers how the architectural designs provide spaces that facilitate community activities, fostering cultural exchanges and social cohesion.	4.64%	C2.3.1/4.64
2.3.2	Assessment examines the effectiveness of these spaces in promoting interaction, inclusivity, and community engagement within the built environment.	4.00%	C2.3.2/4.00

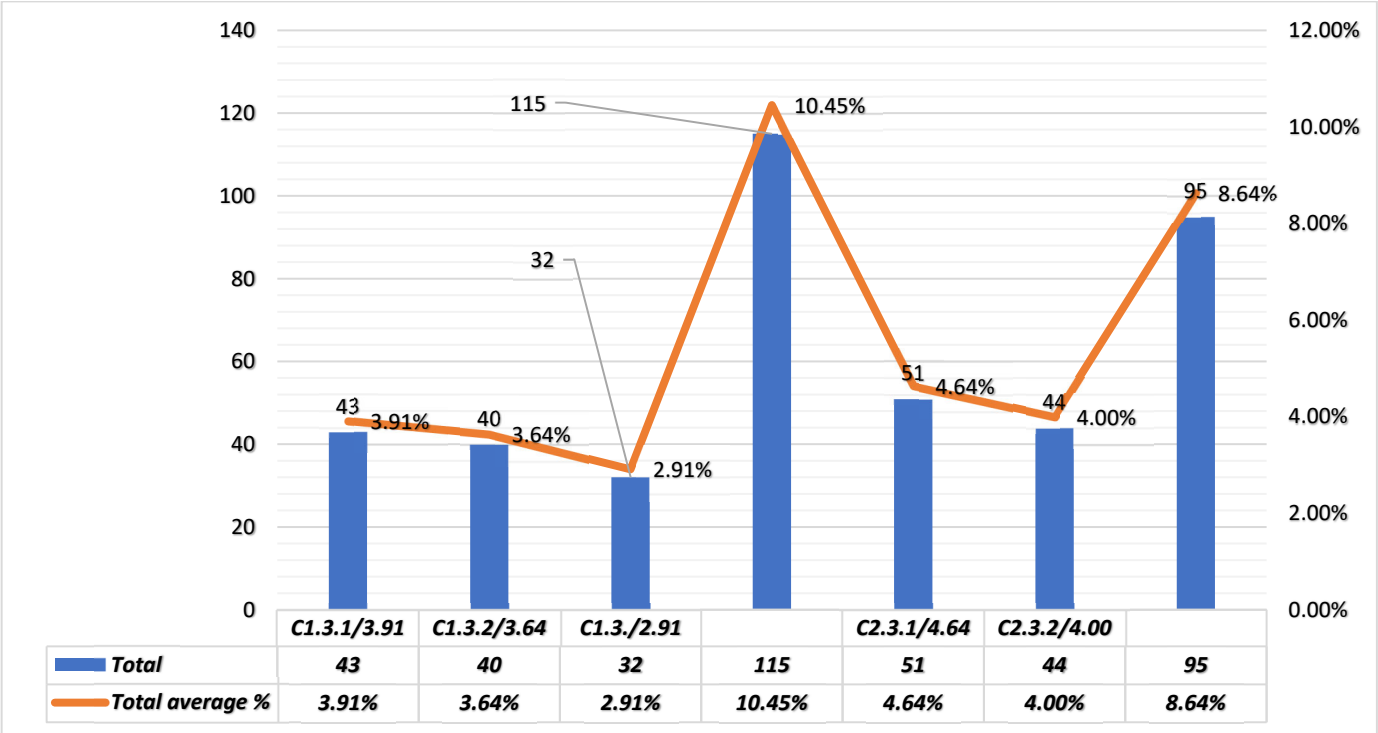


Figure 5. Diagram displaying measurements and results of the cultural integration criterion and sub-criterion.

On the other hand, it had the least weight, which means that it could be a less important point in this context with 3.17%, and, therefore, one that should be given more attention in further research. Table 5 assesses the connectivity of urban areas in terms of pedestrian-friendly infrastructure and public transport facilities. The performance of the indicators reflects significant gaps: for example, the integration of pedestrian-friendly infrastructure (U1.4.1) was 1.71%, while the effectiveness of public transport and connected public spaces was lower at 1.46% (U1.4.2). These low percentages lead us to consider the idea that there is a significant lack of consideration of walkability and accessibility in the urban environment, perhaps indicating that the experts participating in the assessment did not fully emphasize supporting the mobility of residents and visitors, as shown in Figure 6.

Table 5. Urban connectivity.

Indicators	Sub-criterion 1.4: Analysis examines how each project promotes urban connectivity through pedestrian-friendly infrastructure, public transportation facilities, and interconnected public spaces.	Total Average %	Code
1.4.1	Analysis examines how the project integrates pedestrian-friendly infrastructure to enhance walkability and accessibility within the urban environment.	1.71%	U1.4.1/1.71
1.4.2	Assessment considers the effectiveness of public transportation facilities and interconnected public spaces in facilitating convenient and seamless movement for residents and visitors alike.	1.46%	U1.4.2/1.46

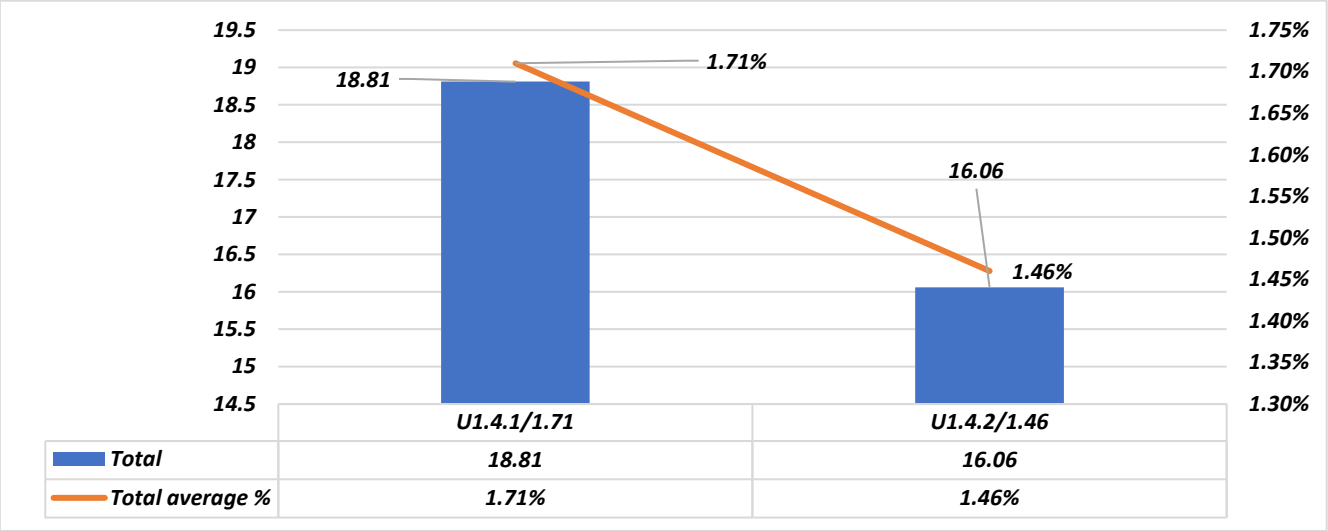
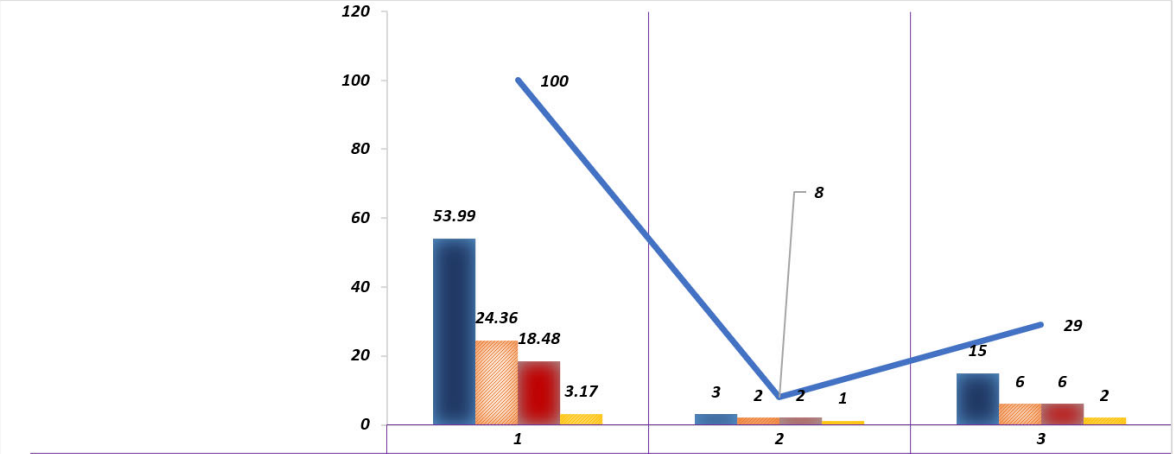


Figure 6. Diagram displaying measurements and results of the urban connectivity criterion and sub-criteria.

The tables confirm the main criteria that support the sustainability assessment as follows: environmental with 53.99%, technological and economic with 24.36%, cultural with 18.48%, and urban connectivity with 3.17%. The leading position of the environmental criterion can be explained by the fact that it covers more than half of the total assessment and, thus, logically plays a fundamental role in shaping sustainable practices and policies. In fact, this criterion is supported by 3 sub-criteria and 15 indicators, which indicates a very broad base for assessing environmental impact.

Then comes the technological and economic criterion, with a weight of 24.36% and two sub-criteria, meaning that advanced technologies and related economic considerations are part of sustainability assessments but do not play the main role. The cultural criterion has a relatively lower weight of 18.48% and includes two sub-criteria, thus stating that cultural integration in sustainability practice is expected but may not be given as much emphasis as the environmental or technological aspects. Urban connectivity represents the lowest level with 3.17%. This means that the weight given to this dimension is minimal, and, therefore, urban connectivity is not really addressed by the proposed sustainability framework derived from experts, as shown in Figure 7. This then becomes a point of concern that could be taken into account in further research and development processes. Indeed, increased mobility and access to new places could prove to be a cornerstone towards better community integration and sustainability, and, therefore, there is a need to focus more on urban connectivity in further studies. The current focus on the environmental criterion is deserved, but an integrated view of sustainability in an urban context will require a balanced approach that gives at least equal weight to issues of urban connectivity and cultural and technological considerations.



	1	2	3
1. Environmental criterion	53.99	3	15
2.Technological & economic criterion	24.36	2	6
3.Cultural criterion	18.48	2	6
4. Urban connectivity criterion	3.17	1	2
Total	100	8	29

Figure 7. Diagram displaying the percentage of each of the four criteria in the total evaluation.

6. Implementing on the Case Studies

All available information on the three projects was sent to the expert committee tasked with determining the weights, in addition to the researchers' participation in the evaluation after determining the evaluation model and determining the weights. These data collection tools included field visits to collect field observations and analytical descriptions, consultation with project stakeholders, and site photography in February 2023. The case projects were selected due to their strategic importance within Riyadh, allowing the study to be more in-depth in their impacts. The three projects were also designed and implemented by international experts, which helps the research in monitoring how to deal with global trends. Given the climatic conditions in Riyadh, this study will receive another boost in environmental feasibility, and special attention will be paid to how architects adapt their strategies to the prevailing environmental conditions. The next part contain short descriptions of each project.

- King Abdullah Financial District (administrative building)

King Abdullah Financial District study and inventory: King Abdullah Financial District KAFD in Riyadh (Figure 8) [63].

Saudi Arabia is one of the mega development projects where major players, such as the Saudi Stock Exchange, the Capital Market Authority, and some international banks, are operating. The KAFD is valued at an estimated USD 7.8 billion is spread over 1.6 million square meters [64]. Community service buildings, such as mosques, should not be thought of as the attractions in any one impressively beautiful and neat tourist areas. These attractions include the Al-Wadi Park–Aquarium and the Museum of the Built Environment to cater to the interests of all types of inhabitants and visitors. A number of design architectural firms [65], including HOK (St. Louis, MO, USA) [66], SOM (Chicago, IL, USA) [67], Gensler (San Francisco, CA, USA) and Foster + Partners (London, UK) [68] were commissioned to deliver the buildings' designs as part of the project. Generally, the project was guided by Henning Larsen Architects. The King Abdullah Financial District is supposed to house around 50,000 residents. Due to the temperatures that exist in Riyadh, numerous options are made available to control the temperature and efficiency in the complex. Cooling of the pedestrian bridges will be provided, and will act as part of a defined network to connect 30 buildings through the installment of a solar power system, as shown in Figure 9.

Figure 8. Aerial view of the King Abdullah Financial District in Riyadh, Saudi Arabia, showcasing the urban layout, and strategic significance, as captured by Google Maps.

Figure 9. The facade design is characterized by a blend of glass facades alongside the utilization of natural materials, like marble (authors: April 2023).

This would, in turn, reduce the environmental impact on the area and at the same time increase access and connectivity within the development. The KAFD has received its LEED Platinum certification for Neighborhood Development from the U.S. Green Building Council [69]. On top of that, the center (the subject of the study) has also received more than 15 certifications at the platinum, gold, and silver levels, respectively, demonstrating a high commitment to sustainable architectural practices. It has also received the Smart Score Platinum certification from Wired Score, proving that the financial center is distinguished by exemplary standards in user experience, cost efficiency, sustainability, and future readiness at the forefront of smart infrastructure. The King Abdullah Financial District is a mark of collaborative excellence, with more than 25 global design and architecture leaders who have contributed to its success. Most of the architectural achievements of this center have been

recognized around the world, such as the Best Good Design Award and the International Architecture Prize for Omrania's design of the KAFD Grand Mosque, Figure 10 [70].

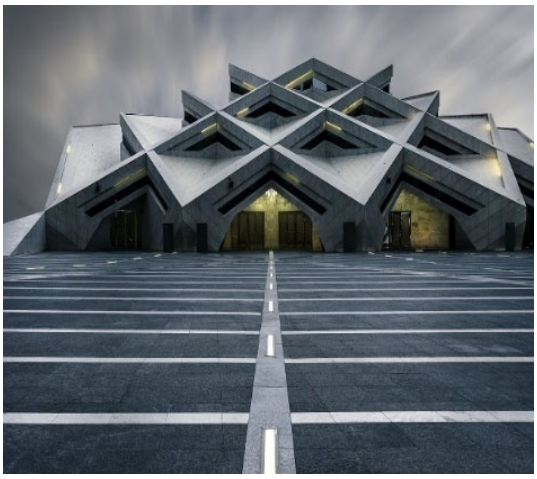


Figure 10. The KAFD mosque was a finalist in the religion section of the World Architecture Festival. The Middle East Architect also listed it as part of their top 10 contemporary mosques that challenge traditional Islamic architecture. Source: https://www.locationscout.net.

- KAFD Metro Station

The King Abdullah Financial District includes the King Abdullah Financial District Metro Station, designed by the famous architect Zaha Hadid, who won the project despite competition from other famous firms, such as Henning Larsen and Hoke [71]. The KAFD Metro Station is shown in Figure 11.

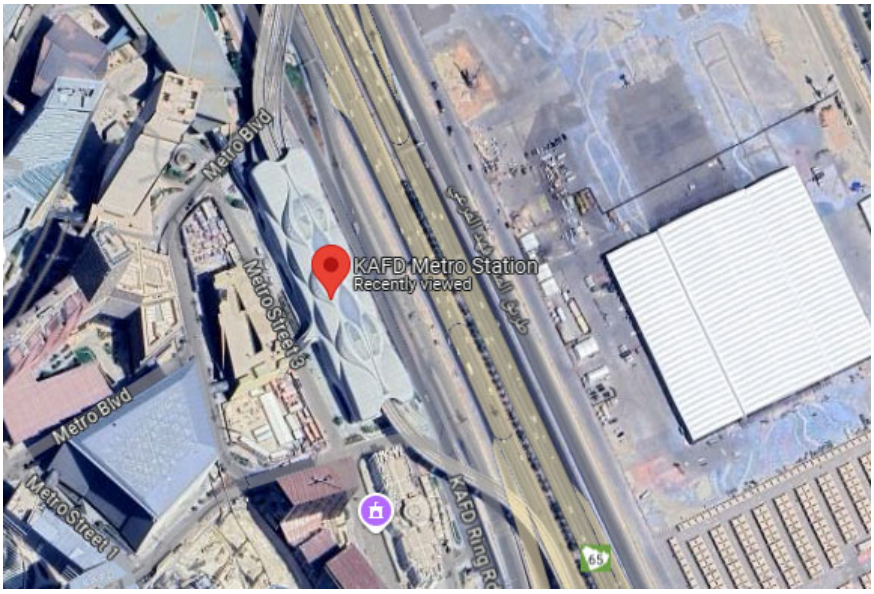


Figure 11. Aerial view of the KAFD Metro Station in Riyadh, Saudi Arabia, showcasing the architectural innovations, urban layout, and strategic significance, as captured by Google Maps.

According to Zaha Hadid Architects, the King Abdullah Financial District Metro Station in Riyadh uses organic design elements from nature; the geometric formations made with meticulous detail can be easily seen from the outside and contribute to dissipating part of the solar heat to preserve the project as a public space for the city. The new building will have six floors with two levels of underground parking. The station is two levels underground, with five levels above ground for car parking, designed to cover a ground

area of 45,000 square meters [72]. The Royal Commission for Riyadh City is realizing the metro project in Riyadh as part of the sustainable development of modern cities, hence meeting the needs of a fast-growing population.

Some of the lines included within the metro network include the Blue Line, Yellow Line, and the Purple Line, among others, with the aim of reducing private car travel by a good percentage [65]. The organic design details of KAFD Metro Station manifest the relationship with nature through smooth line. As seen in Figure 12, intricate patterns give the station a reduced solar heat image, representing its relationship with the surrounding desert. It can be envisaged as a multifunctional public platform rather than a transport hub as Riyadh moves into the future of all-inclusive urban development [65].

Figure 12. One of the important aspects of globalization may be taking advantage of modern techniques and advanced technology in implementing forms in a manner consistent with the vision of the architect Khassi in projects that represent an important landmark in the city. Source: https://newtecnic.com/.

- King Abdullah Petroleum Studies and Research Center (KASARC)

The King Abdullah Petroleum Studies and Research Center (KAPSARC) serves as a research and advisory organization, specializing in global energy economics and sustainability [73], and is shown in Figure 13. KAPSARC aims to improve sustainable energy practices and advance understanding of energy economics worldwide, leveraging multidisciplinary approaches to deliver real value and tangible results at global scale. The project covers an area of 70,000 square meters and consists of five separate buildings. These include the Energy Knowledge Center, the Energy Computer Center, and the Conference Center. Having obtained observer status with the United Nations Environment Program, the center has gained wide fame by receiving many awards and accreditations. The project has been awarded LEED Platinum certification, and incorporates advanced passive cooling techniques through the use of wind traps for natural ventilation [74].

The project also achieves increased community connectivity through pedestrian access to a central public plaza. Each building has a hexagonal cellular envelope blocking natural light and an integrated crystalline shape, allowing it to blend into the desert landscape and protecting interior spaces from direct sunlight, amplifying natural cooling processes, and allowing transparency between researchers and visitors. The engineering teams working on the project had to develop repeatable structural envelopes using a PTFE glass fabric that could meet the requirements of high transparency versus strength, as shown in Figure 14.

Figure 13. Aerial view of the KAPSARC in Riyadh, Saudi Arabia, showcasing architectural innovations, urban layout, and strategic significance, as captured by Google Maps.

Figure 14. The KAPSARC's architectural design demonstrates a considered approach to environmental response, aligning with sun and wind patterns to optimize natural light, ventilation, and cooling. By adapting to the environmental conditions of the Riyadh Plateau, the KAPSARC reduces energy consumption and promotes a sustainable built environment. Source: KAPSARC—tensile fabric building skin.

7. Results (Implementation of the Evaluation Model)

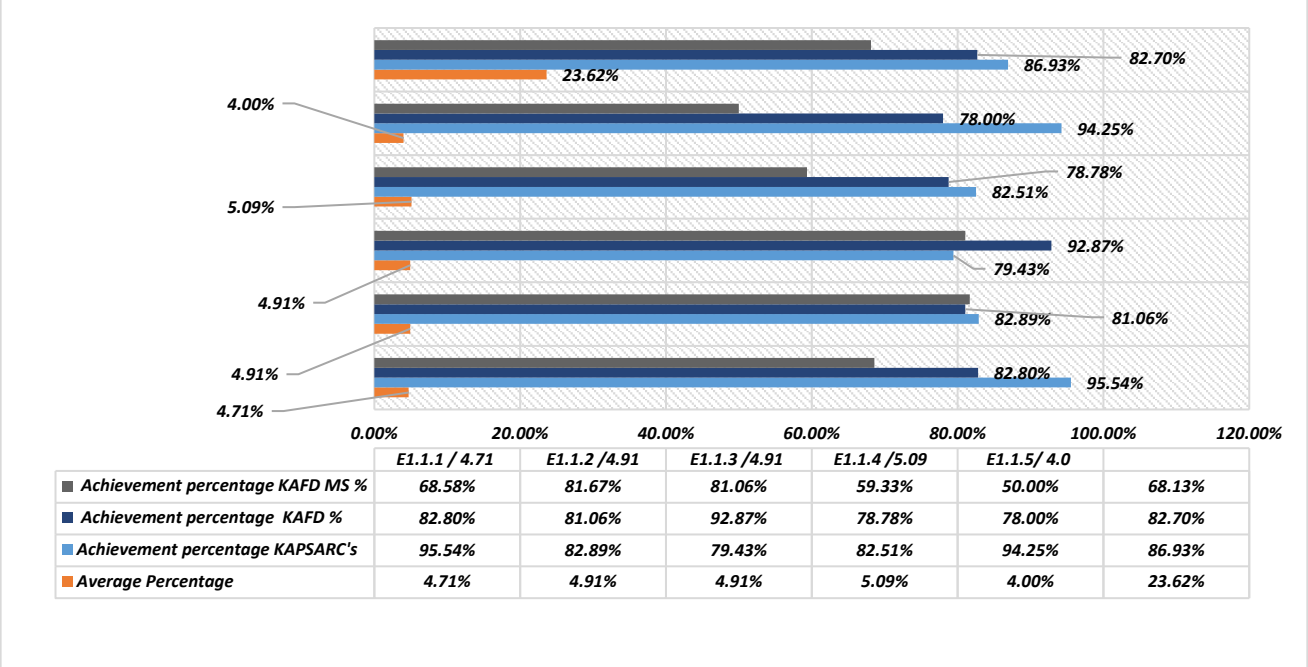
In the next phase of the research, the results of the analysis of the projects described above will be presented in brief, highlighting the key findings and insights drawn from the data collected. We will begin by tabulating the results and then analyzing them, as seen in Table 6. This overview will serve as a basis for a deeper discussion, exploring the implications of these findings in relation to the overall objectives of the research. Factors, such as project effectiveness, sustainability, and contribution to the field will be examined. In addition, potential challenges encountered during the analysis will be addressed, along with recommendations for future research directions.

Analysis: For sub-criterion 1—Sustainable Design, the KAPSARC's project, achieved an overall average of 86.93% through expert judgment assessment, with an average variance of 4.0% from the KAFD. The KAPSARC's high performance was supported by a score of 95.54% in certain criteria, such as LEED certification and implementation of advanced technologies, while the analysis of materials selection based on sustainability criteria resulted in a score of 94.25%. The KAFD, in turn, showed average results in the advanced technologies applied sub-criteria (92.87%), while its energy consumption rating was much

lower and fairer at 78.78%. The average in the measurement results was 68.13% higher than the average for the KAFD Metro Station, as in Figure 15.

Table 6. Results of the analysis of the first criterion (evaluation of the environmental criterion).

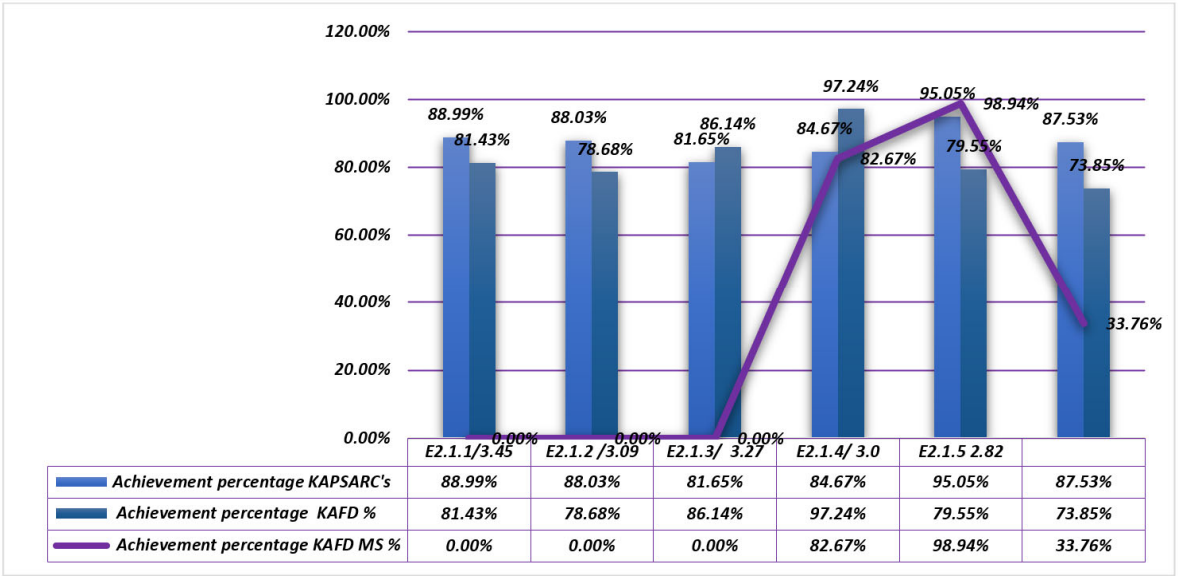
Main Criterion (The Environmental Criterion)					
Indicators	**Sub-Criterion 1.1—Sustainable design (assessment includes criteria, such as LEED certification, use of advanced technologies, and design features aimed at reducing environmental impact).**	**Code**	**Achievement Percentage KAPSARC's**	**Achievement Percentage KAFD %**	**Achievement Percentage KAFD MS %**
1.1.1	Assessment includes criteria, such as LEED certification, use of advanced technologies, and design features aimed at reducing environmental impact.	E1.1.1/4.71	4.5	3.9	3.23
1.1.2	Evaluation of compliance with LEED (Leadership in Energy and Environmental Design) certification standards.	E1.1.2/4.91	4.07	3.98	4.01
1.1.3	Assessment of the integration and effectiveness of advanced technologies in building systems.	E1.1.3/4.91	3.9	4.56	3.98
1.1.4	Review of design features aimed at reducing energy consumption and environmental impact.	E1.1.4/5.09	4.2	4.01	3.02
1.1.5	Analysis of materials selection based on sustainability criteria and lifecycle assessment.	E1.1.5/4.0	3.77	3.12	2
	Total score 23.62 of 100		20.44	19.57	16.24
Main Criterion (Environmental)					
Indicators	**Sub-criterion 2.1—Urban heat island effect (evaluation considers strategies to mitigate heat island effects through architectural design).**	**Code**	**Achievement Percentage KAPSARC's**	**Achievement Percentage KAFD %**	**Achievement Percentage KAFD MS %**
2.1.1	Implementation of cool roofs and pavements to reduce surface temperatures.	E2.1.1/3.45	3.07	2.5	0.00
2.1.2	Integration of shade structures and vegetation to minimize solar heat gain.	E2.1.2/3.09	2.72	2.14	0.00
2.1.3	Design of urban layouts to maximize natural ventilation and airflow.	E2.1.3/ 3.27	2.67	2.3	0.00
2.1.4	Selection of heat-resistant materials and finishes to reduce heat absorption.	E2.1.4/3.0	2.54	2.47	2.48
2.1.5	Use of water features and thermal mass to enhance cooling effects in the environment.	E2.1.5 2.82	2.69	2.14	2.80
	Total score 15.64		13.69	11.55	5.28
Main Criterion (Environmental Assessment)					
Indicators	**Sub-Criterion 3.1—smart building technology (includes assessment of advanced building technologies implemented to enhance energy efficiency, occupant comfort, and operational performance).**	**Code**	**Achievement Percentage KAPSARC's**	**Achievement Percentage KAFD %**	**Achievement Percentage KAFD MS %**
3.1.1	Evaluation of energy-efficient HVAC systems and their impact on overall energy consumption.	E1.11/4.71	2.78	2.67	2.19
3.1.2	Assessment of smart building technologies for optimizing energy use and enhancing operational efficiency.	E3.12/3.36	2.85	2.85	2.16
3.1.3	Review of advanced lighting systems designed to reduce energy consumption while improving occupant comfort.	E3.13/2.82	2.45	2.56	1.98
3.1.4	Analysis of building automation systems (BAS) and their effectiveness in managing and monitoring building operations.	E3.4/2.64	2.21	2.54	2.32
3.1.5	Examination of renewable energy integration (e.g., solar panels, wind turbines) and its contribution to energy efficiency and sustainability goals.	E3.5/2.82	1.85	1.85	1.07
	Total 14.73 of 100		12.14	12.47	9.72



	E1.1.1 / 4.71	E1.1.2 /4.91	E1.1.3 /4.91	E1.1.4 /5.09	E1.1.5/ 4.0	
Achievement percentage KAFD MS %	68.58%	81.67%	81.06%	59.33%	50.00%	68.13%
Achievement percentage KAFD %	82.80%	81.06%	92.87%	78.78%	78.00%	82.70%
Achievement percentage KAPSARC's	95.54%	82.89%	79.43%	82.51%	94.25%	86.93%
Average Percentage	4.71%	4.91%	4.91%	5.09%	4.00%	23.62%

Figure 15. Diagram showing the results of Sub-criterion 1.1—Sustainable Design (assessment includes criteria, such as LEED certification, use of advanced technologies, and design features aimed at reducing environmental impact).

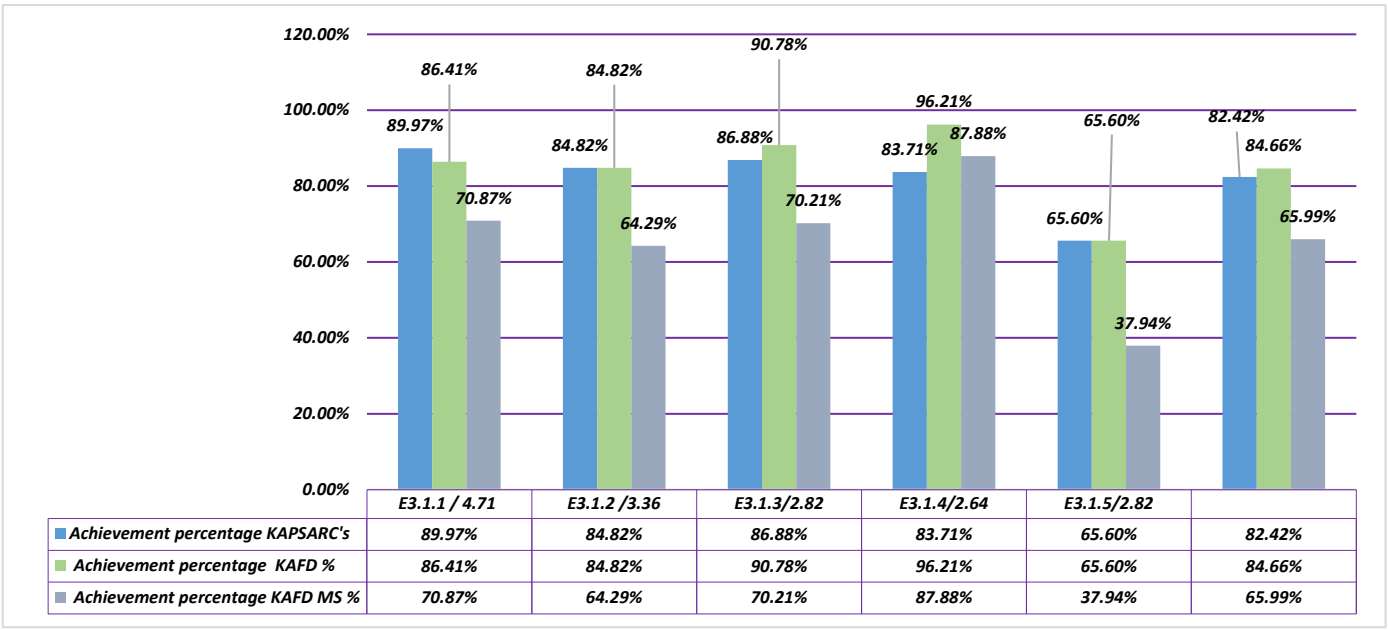
The second sub-criterion concerns the assessment of the urban heat island effect, where KAPSARC achieved a high overall score of 87.53%, to show appropriate strategies which have been put in place to reduce the effects of the heat island, recording a score of 95.05% regarding the use of water features and thermal mass. The King Abdullah Financial District scored very strongly in the selection of heat-resistant materials, with a score of 97.24%, while all other indicators were comparatively low. In sharp contrast, the King Abdullah Financial District Metro Station received a score of only 33.76%, which underlines that the project did not undergo adequate studies before being implemented, as shown in Figure 16.



	E2.1.1/3.45	E2.1.2 /3.09	E2.1.3/ 3.27	E2.1.4/ 3.0	E2.1.5 2.82	
Achievement percentage KAPSARC's	88.99%	88.03%	81.65%	84.67%	95.05%	87.53%
Achievement percentage KAFD %	81.43%	78.68%	86.14%	97.24%	79.55%	73.85%
Achievement percentage KAFD MS %	0.00%	0.00%	0.00%	82.67%	98.94%	33.76%

Figure 16. Results of Sub-criterion 2.1—Smart Building Technology (includes assessment of advanced building technologies implemented to enhance energy efficiency, occupant comfort, and operational performance).

Analysis: While the ranking of "Smart Building Technology" is another story, the KAPSARC shows the overall highest achievement of 82.42% and is very strong in terms of energy-efficient HVAC systems, with a score of 89.97%. On the other hand, the KAFD, has a score of 84.66%, yet attains the highest level for this project in terms of building automation system, scoring as high as 96.21%. However, the KAFD MS scored only 65.99%; thus, it needs further changes in implementation when it comes to smart technologies, especially since it recorded a 37.94% in terms of renewable energy integration. This shows that KAFD MS has to be strategically enhanced in terms of renewable energy adoption as well as in terms of the integration of advanced smart technologies that will increase the efficiency of operation and enhance occupant comfort (Figure 17).



	E3.1.1 / 4.71	E3.1.2 /3.36	E3.1.3/2.82	E3.1.4/2.64	E3.1.5/2.82	
Achievement percentage KAPSARC's	89.97%	84.82%	86.88%	83.71%	65.60%	82.42%
Achievement percentage KAFD %	86.41%	84.82%	90.78%	96.21%	65.60%	84.66%
Achievement percentage KAFD MS %	70.87%	64.29%	70.21%	87.88%	37.94%	65.99%

Figure 17. Results of Sub-criterion 3.1—Smart Building Technology (includes assessment of advanced building technologies implemented to enhance energy efficiency, occupant comfort, and operational performance).

The evaluation of "International Expertise" across the KAPSARC, KAFD, and KAFD Metro Station (KAFD MS) shows that collaboration with internationally renowned architecture firms provides a strong driving force for design innovation and technological advancement, as in Table 7. The KAPSARC leads at 93.46%, indicating outstanding performance in ensuring the development of innovative designs, expressed at 94.15% for TS1, and incorporating third-party views, depicted at 96.41% for TS3. This is indicative of great concentration on holistic project development. The KAFD comes next with 90.75%, mainly catching up through integrating technology developments at 94.62% for TS2. While the KAFD scored 83.73% in the portrayal of varied standpoints, there is yet more room for improvement in this regard. Overall, the KAFD MS scored 84.05%, which in itself is laudable; however, it suffers in terms of presenting diverse perspectives, since its score was only 73.21%. This indicates that the station must improve its effectiveness in terms of its cultural and contextual relevance to the environment. More emphasis will have to be directed toward incorporating a greater scope of perspectives if project improvement is to be effectively consistent with the community and the needs emerging therein (Figure 18).

In the "Role as Economic Hub" analysis, the King Abdullah Petroleum Studies and Research Center and King Abdullah Financial District succeeded in attracting international businesses overall, with a score of 83.33% achieved by the KAPSARC and a score of 87.82% achieved by the KAFD. The King Abdullah Petroleum Studies and Research Center performed especially well in attracting a house of multinational corporations, with a score

of 89.24% for TS4, and in enhancing the reputation of Riyadh in the global perspective, with a score of 86.48% for TS6. By contrast, the KAFD Metro Station KAFD Metro Station came last in this analysis, with an overall achievement of 69.71%, especially lagging behind in terms of business attraction score, which it obtains only 50.61% in TS4. This indicates that KAFD Metro Station needs to increase its presence and relevance while genuinely exercising strategic moves, as shown in Figure 19.

Table 7. Results of the analysis of the second criterion (the technological and economic criterion).

Assessment of Technological and Economic Criterion					
Indicators	**Sub-Criterion 1.2—International expertise (impact of collaborating with global architecture firms on design innovation, technological advancements, and the integration of diverse perspectives into project development).**	**Code**	**Achievement Percentage KAPSARC's**	**Achievement Percentage KAFD %**	**Achievement Percentage KAFD MS %**
1.2.1	Assessment of design innovation fostered through collaboration, including the introduction of new architectural concepts, materials, or construction techniques.	T1.2.1/4.07	4.02	4.01	3.78
1.2.2	Evaluation of technological advancements integrated into projects through collaborative efforts, such as the adoption of advanced building systems, sustainable technologies, or digital design tools.	T1.2./4.09	3.67	3.87	3.70
1.2.3	Analysis of how collaboration with global firms enhances project development by integrating diverse cultural, environmental, and technical perspectives, contributing to holistic and innovative design solutions.	T2.3/4.18	4.03	3.5	3.06
	Total 12.54 of 100		11.72	11.38	10.54
Indicators	**Sub-Criterion 2.2—Role as economic hub (project contributes to economic integration by attracting international businesses, fostering cross-border investments, and enhancing the city's local role as a global economic hub).**	**Code**	**Achievement Percentage KAPSARC's**	**Achievement Percentage KAFD %**	**Achievement Percentage KAFD MS %**
2.2.1	Assessment of the project's ability to attract international businesses and multinational corporations to establish operations or headquarters in Riyadh.	T2.2.1/4.09	3.65	3.63	2.07
2.2.2	Assessment of the project's ability to attract international businesses and multinational corporations to establish operations or headquarters in Riyadh.	T2.2.2/4.18	3.13	3.67	3.09
2.2.3	Analysis of the project's impact on enhancing Riyadh's reputation and role as a global economic hub by promoting international trade, commerce, and investment opportunities in the region.	T2.2.3/3.55	3.07	3.08	3.08
	Total 11.82 of 100		9.85	10.38	8.24

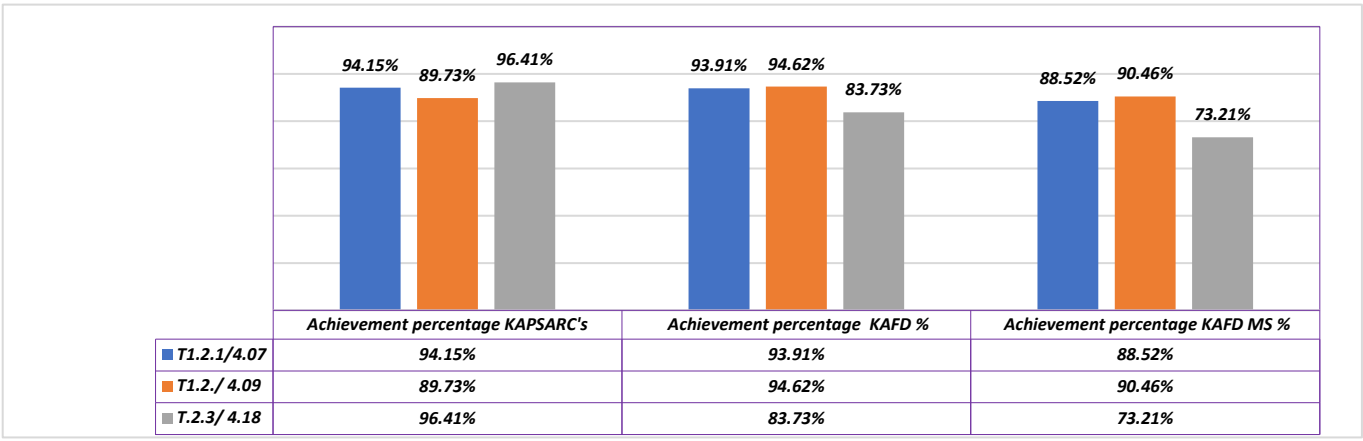


Figure 18. Results of Sub-criterion 1.2—International Expertise (impact of collaborating with global architecture firms on design innovation, technological advancements, and the integration of diverse perspectives into project development).

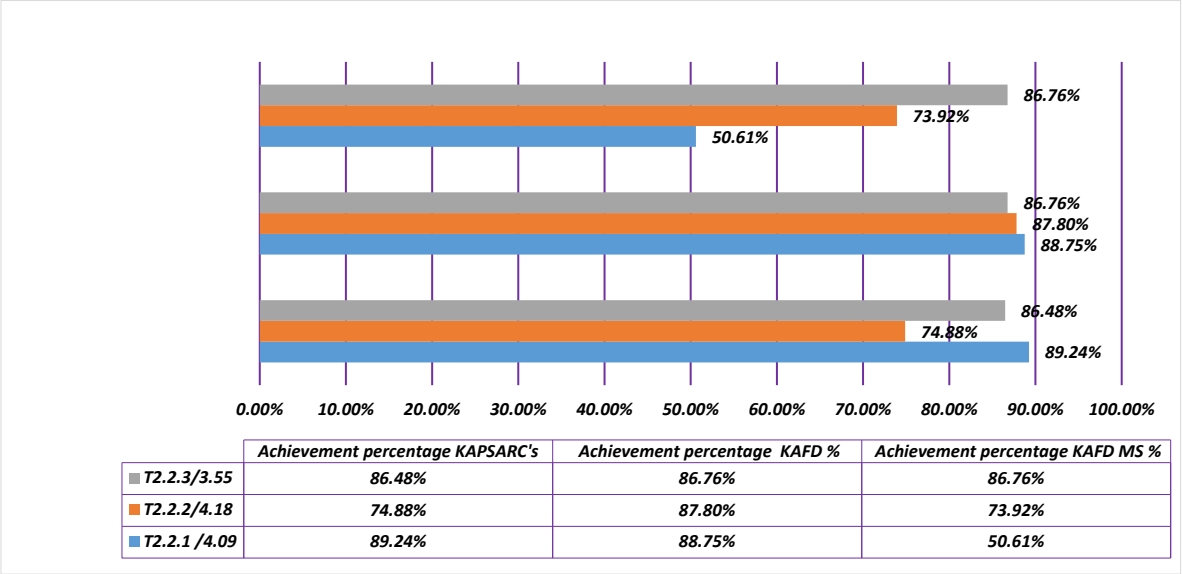


Figure 19. Results for Sub-criterion 2.2—Role as Economic Hub (project contributes to economic integration by attracting international businesses, fostering cross-border investments, and enhancing local role as a global economic hub).

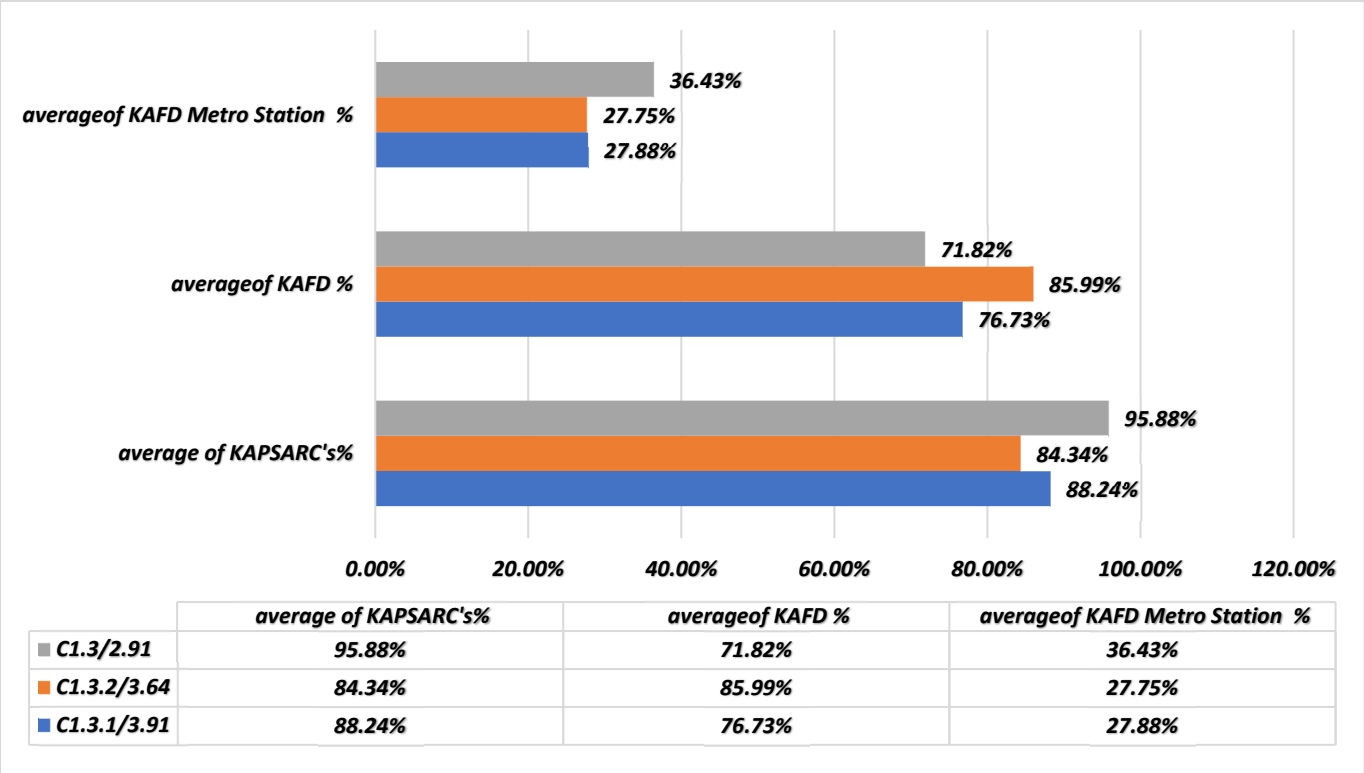
Cultural integration was analyzed in the KAPSARC, KAFD, and KAFD Metro Station design concepts with various degrees of success for the implementation of Saudi Arabian Culture, as shown in Table 8. The KAPSARC has the highest average with 89.01%, so it represents an effective incorporation of traditional Saudi architectural styles, showing the highest scoring of 88.24% for motif–material incorporation, as can be seen clearly from the graph.

Table 8. Results of the analysis of the third criterion (cultural criterion).

Cultural Criterion					
Indicators	**Sub-Criterion 1.3—Cultural integration (assessment considers the incorporation of saudi cultural elements and architectural heritage into design concepts).**	**Code**	**Achievement Percentage KAPSARC's**	**Achievement Percentage KAFD %**	**Achievement Percentage KAFD MS %**
1.3.1	Does the project integrate traditional Saudi architectural styles, motifs, or materials into its design?	C1.3.1/3.91	3.45	3	1.09
1.3.2	Encompassing the project's sensitivity to local cultural values, customs, and aesthetic preferences.	C1.3.2/3.64	3.07	3.13	1.01
1.3.3	Examining how the incorporation of Saudi cultural elements enhances the project's identity, authenticity, and sense of place within its local context	C1.3.3/2.91	2.79	2.09	1.06
	Total 10.64 of 100		9.31	8.22	3.16
Indicators	**Sub-Criterion 2.3—Community engagement (provision of spaces for community activities, cultural exchanges, and social cohesion within the architecture).**	**Code**	**Achievement Percentage KAPSARC's**	**Achievement Percentage KAFD %**	**Achievement Percentage KAFD MS %**
2.3.1	Evaluation considers how the architectural designs provide spaces that facilitate community activities, fostering cultural exchanges and social cohesion.	C2.3.1/4.64	3.45	3	1.09
2.3.2	Assessment examines the effectiveness of these spaces in promoting interaction, inclusivity, and community engagement within the built environment.	C2.3.2/4.00	3.07	3.13	1.01
	Total 7.84 of 100		9.31	8.22	3.16

Additionally, the KAPSARC's sensitivity to local cultural values achieved 84.34%, and its ability to enhance project identity and authenticity scored a remarkable 95.88%. In

contrast, the KAFD MS project shows a significant gap, especially in integration with local reality at 27.88%. Overall, enhancing cultural integration in the KAFD MS project is crucial to fostering a deeper connection with the local context and community identity, as shown in Figure 20.



	average of KAPSARC's%	averageof KAFD %	averageof KAFD Metro Station %
C1.3/2.91	95.88%	71.82%	36.43%
C1.3.2/3.64	84.34%	85.99%	27.75%
C1.3.1/3.91	88.24%	76.73%	27.88%

Figure 20. Diagram of results for Sub-criterion 1.3—Cultural Integration (assessment considers the incorporation of Saudi cultural elements and architectural heritage into design concepts).

The evaluation of community engagement within the KAPSARC, KAFD, and KAFD Metro Station highlights the place provision for cultural exchange and social cohesion: KAPSARC reported an average score of 30.99%, indicating moderate effectiveness in creating spaces that foster community activities, with a score of 28.23% for facilitating these spaces.

At a slightly lower rank, the KAFD reached an overall average of 23.60%, with a focus on inclusivity reflected in its scoring of 57.81% for the assessment of the effectiveness of these spaces. In very strong contrast, the KAFD MS scored very highly in terms of community engagement, with an overall of score 85.84% and a perfect score of 100.00% regarding space for community activities. It was a sign of strong resolve aimed at the betterment of social interaction and cultural exchange, probably acting as a model for future architectural projects with the aim of integrating communities. The results indicate that the KAFD MS may benefit from sharing best practices with the KAPSARC and KAFD to further improve its community engagement strategies, as shown in Figure 21.

According to Table 9 and through analysis, it was found that the KAFD achieved a very high pedestrian infrastructure achievement rate of 90.06%, while in the KAFD, it was only 65.50%, proving that the KAFD promotes walkability more effectively. For the effectiveness of public transport facilities, the KAFD has an advantage of 91.78% versus the KAFD's 80.14%. The total speaks for the KAFD's stronger performance in ensuring smooth movement and accessibility, with a score of 90.85%, while the KAFD's is 72.24%, indicating further improvement in its urban connectivity strategy (Figure 22).

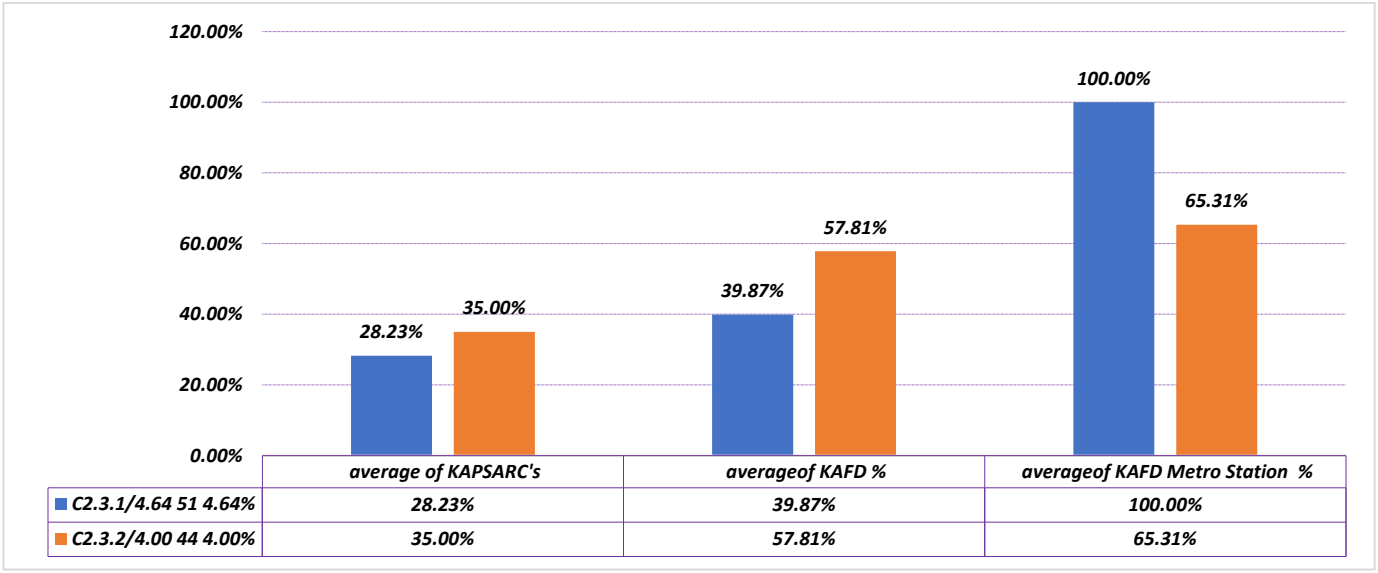


Figure 21. Diagram of the results for Sub-criterion 2.3—Community Engagement (provision of spaces for community activities, cultural exchanges, and social cohesion within the architecture).

Table 9. Results of the analysis of the fourth criterion (Urban connectivity criterion).

Urban Connectivity					
Indicators	**Sub-Criterion 1.4—Analysis examines how each project promotes urban connectivity through pedestrian-friendly infrastructure, public transportation facilities, and interconnected public spaces.**	**Code**	**Achievement Percentage KAPSARC's**	**Achievement Percentage KAFD %**	**Achievement Percentage KAFD MS %**
1.4.1	Analysis examines how the project integrates pedestrian-friendly infrastructure to enhance walkability and accessibility within the urban environment.	U1.4.1/1.71	1.12	1.54	1.43
1.4.2	Assessment considers the effectiveness of public transportation facilities and interconnected public spaces in facilitating convenient and seamless movement for residents and visitors alike.	U1.4.2/1.46	1.17	1.34	1.30
	Total 3.17 of 100	3.17	2.29	2.88	2.73

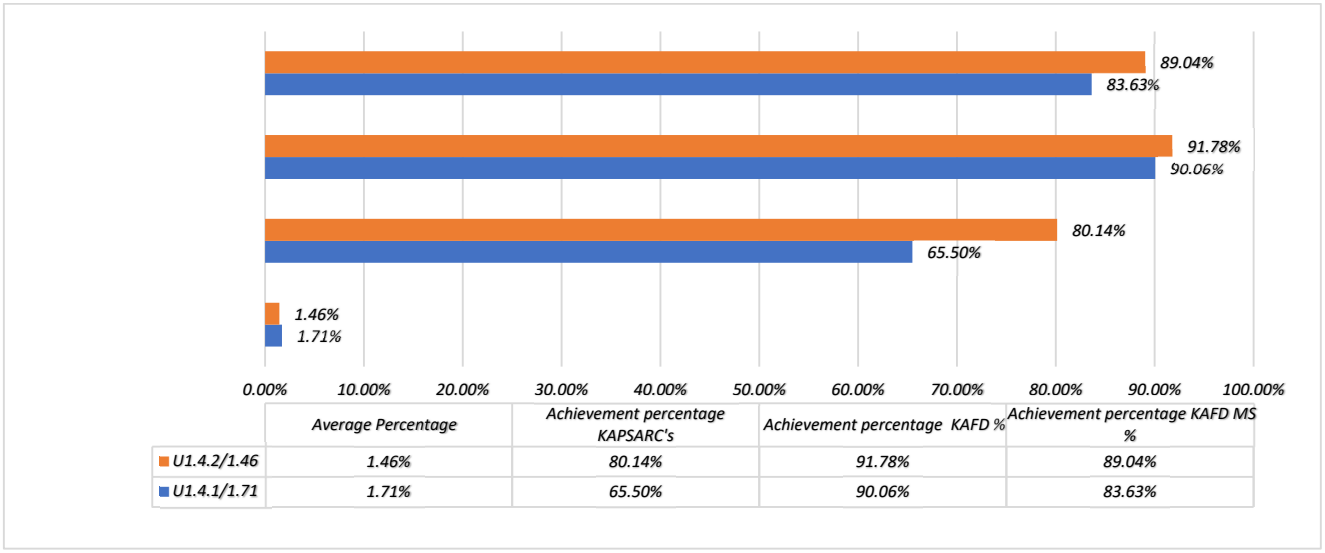


Figure 22. Results for Sub-Criterion 1.4: analysis examines how each project promotes urban connectivity through pedestrian-friendly infrastructure, public transportation facilities, and interconnected public spaces.

8. Discussion

1. The environmental assessment indicates a significant gap between the KAPSARC and other projects in terms of sustainable design and environmental impact. According to the points described, the KAPSARC has demonstrated excellence in achieving the highest standards in terms of sustainability, especially with regard to LEED certification and the selection of the most advanced materials, which tend to focus on the project's commitment to having a minimal environmental impact. While the KFDC demonstrated proficiency in energy efficiency technologies, it failed to effectively reduce energy consumption and the urban heat island effect. It scored significantly lower in several measures of use of heat-resistant materials and strategies towards incorporating water features. To this end, although both projects received an award for sustainability, the KAPSARC's superior approach to sustainable design methodologies distinguishes it as a leading model for future developments that seek environmental sustainability.
2. From a technological and economic perspective, the KAPSARC achieved above-average performance in smart building technologies, with particular attention to energy-efficient systems. The project scored highly for HVAC efficiency and improved building technologies, meaning it has sufficiently improved occupant comfort and operational efficiency. From an economic perspective, the KAPSARC's strategy will yield significant cost savings in the long run and is, therefore, a very financially responsible investment by stakeholders. The KAFD also scored close in most categories but came out on top for building automation systems, demonstrating a strong position in operational management. Likewise, at the KAFD, the deliberate integration of technological solutions serves to better manage its resources and reduce operating costs; therefore, it is economically viable. However, the integration of renewable energy still has room for improvement in the relatively low score of the KAFD Metro Station. The adoption of renewable technology is crucial to achieving long-term sustainability goals. The results indicate that while both projects benefit from technological advances, KAPSARC's approach is truly comprehensive in integrating energy efficiency with innovative technology while maximizing economic benefits.
3. Cultural integration is a strong feature of good urban architecture, and the review represents a diverse level of effectiveness within projects related to integrating Saudi culture. The development of the King Abdullah Petroleum Studies and Research Center has performed very well and recorded very impressive results in terms of integrating traditional Saudi architectural styles and motifs, demonstrating a thoughtful consideration of local values and aesthetics. This focus not only enhances the identity of the project, but also builds a sense of place. While the King Abdullah Petroleum Studies and Research Center, and particularly the King Abdullah Petroleum Studies and Research Center Metro Station, revealed very low scores in terms of cultural sensitivity and integration, the integration of local context into its designs, and the lack of attention to cultural integration in the King Abdullah Petroleum Studies and Research Center Metro Station, suggests greater enhancement of connections to community identity and practices as a potential channel towards enhancing social relevance and acceptance.
4. The analysis of urban connectivity highlights significant variation in how the King Abdullah Petroleum Studies and Research Center promotes mobility within the urban environment. The fact that the KFH scores highly on pedestrian-friendly infrastructure and public transport facilities, which are well connected to walkability and accessibility for its residents and visitors, should first be emphasized as an important point of convergence for strategic thinking on well-integrated transport and urban planning models. On the other hand, the KFH performed weaker in this direction, which seems to indicate a potential need to improve connectivity initiatives in its design. In addition, the KFH Metro Station demonstrated excellent practice in terms of community social connectivity. Future development should learn from the KFH in

envisioning such integrated urban environments where community characteristics are alive and vibrant, and the resulting services will enhance the overall urban experience of Riyadh.

9. Conclusions

The results of the study found that there were four key criteria to evaluate sustainability in architectural projects in Riyadh, and, thus, reflect the importance of the interaction between environmental integrity, technological advancement, cultural integration, and urban connectivity that occurs in an urban development framework in achieving the objectives of Vision 2030. The highest weight was taken by the environmental criterion, at 53.99% of the overall assessment, which notifies the ever-increasing recognition of sustainability as a cornerstone in the process of urban development. It includes three sub-criteria, namely sustainable design, the urban heat island effect, and smart building technology. For all these, the KAPSARC achieved exemplary scores, especially in features related to LEED certification and the implementation of energy-efficient technologies, demonstrating a high commitment to reducing environmental impacts. The fact that the King Abdullah Financial District Metro Station received much lower ratings indicates a gap in the translation of stringent sustainability criteria, particularly in terms of the implementation of advanced technologies and cultural regulations that reflect the ongoing difficulties residents face in their use of modernity versus authenticity in architectural practices. On the other hand, the technological and economic criterion, which received a weighting of 24.36%, is reinforced by the need to collaborate with international companies to encourage innovation; it also indicates that there are contradictions between marketing the idea of collaboration with international expertise. The cultural criterion accounted for 18.48%, and while most of the architectural designs showed a reflection of local cultural heritage in their design, inconsistencies in projects' attempts to fuse this with the structure's architecture were noted in critical analyses in certain instances, such as at the KAFD Metro Station, for failing to be culturally sensitive. The urban connectivity criterion comprises only 3.17% of the weighting, showing that there is an urgent need to improve how projects are designed to be more conducive to community connectivity with efficient public transport systems that can facilitate movement by residents. The low score in this category reflects the disconnect in the way urban design principles, designed to facilitate access and inclusion, fail in practice. Collectively, these findings underscore the fact that while the ambitious projects studied in Riyadh clearly demonstrate a commitment to sustainability, they also reveal an urgent need to enhance urban connectivity and cultural relevance in architectural practices. This may point to a more balanced approach to creating a sustainable urban environment that truly serves the community and improves the quality of urban life. This means that, in the future, strategies for environmental performance will need to be formulated in a way that not only integrates technological innovation, but also the cultural and social fabric of the city itself, so that progress can keep pace with aspirations and a sense of belonging in a rapidly changing urban landscape. Overall, the proposed evaluation model was useful in testing projects by providing a blueprint that identifies various strengths and weaknesses. An in-depth evaluation of this kind will serve as useful guidance for architects in pursuing sustainability, technological integration, cultural significance, economic feasibility, and urban connectivity in future projects. Another key evaluation, which indicated a strong commitment to sustainable design, was given to the KAPSARC, with high scores, such as 95.54% for sustainable design and 94.25% for advanced material selection, while an impressive 89.97% energy efficiency was recorded for its HVAC systems. Meanwhile, the KAFD received a high score of 96.21% for building automation, and in terms of urban connectivity, it earned an impressive score of 90.85% for pedestrian-friendly infrastructure. Both projects, however, need to improve the shortfalls that were observed with respect to cultural integration, since the KAPSARC scored 89.01% in introducing local architectural styles and habits of renewable energy resources, whereas the King Abdullah Financial District Metro Station scored a very low percentage of 37.94%,

related to the sensitivity that was considered related to a culture. This paper also extends the approaches to the assessment of architectural sustainability and, consequently, underscores the importance for consideration of those built environment aspects that are not measured. It thus advocates a design that is inclusive, balancing principles of sustainable engineering with cultural and social considerations in Riyadh's urban landscape in order to further enrich the identity of its community.

10. Research Limitations

This research into developing an integrated analytical framework for the sustainability assessment of architectural projects in Riyadh is informative, yet simultaneously it has certain limitations, which provide an opportunity for the future improvement of the research. The focus is on a small group of expert respondents, bearing in mind that of the 17 contacted, 11 responded. Further expansion of the panel to include more significant and more varied groups might lead to even more complete and representative results. While the context-specific nature of the research, therefore, primarily reflects the unique dynamics in Riyadh, it is also a strong case study that might stir similar assessments for other urban settings, oriented toward their respective specific cultural and environmental challenges. It further underlines the subjective nature of expert evaluations, which might come with variegated perspectives that could enhance the dialogue on effective sustainability practices in any future assessment. In addition, by acknowledging that sustainability is a developing area, this places the present research as a well-timed contribution to be altered as the development of new technologies and practices emerges. The sources for data collection utilized, from site visits to project documentation and expert evaluation, offer a sound basis on which the surveyed projects can be clearly comprehended; however, future studies need to explore further other relevant factors. While the study in question focuses on quantitative assessments, such community qualitative inputs will add the depth of perspectives and experiences required. Overall, this then leaves room for further improvement and greater in-depth study in the vital field of sustainability assessment.

Author Contributions: H.S.S. played a central role in conceptualizing ideas, formulating overarching research goals and aims, and designing the methodology, including creating models. H.S.S. also conducted experiments, oversaw data collection, and contributed significantly to the investigation process. M.S.M. contributed to data curation, formal analysis, and validation. A.A. was instrumental in project administration, managing research activities, coordinating planning and execution, securing financial support, and contributing to the formulation of research goals leading to this publication. A.A. also contributed to resources. All authors, including H.S.S., M.S.M. and A.A., participated in writing, reviewing, editing, critically revising, commenting, and revising the paper at various stages. H.S.S. additionally played a key role in language review to ensure clarity and coherence in the manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported and funded by the Deanship of Scientific Research at Imam Mohammad Ibn Saud Islamic University (IMSIU) (grant number IMSIU-RG23071).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The authors have agreed to share the data which is included in the manuscript without any conditions.

Acknowledgments: The authors extend their sincere appreciation to Imam Muhammad bin Saud Islamic University for its generous financial support and facilitation of the research. University support played an essential role in the successful implementation of this study, contributing to the advancement of knowledge in the relevant field. Additionally, the authors express gratitude to Ashraf Salama, Head of the Department of Architecture and Built Environment at Northumbria University in the United Kingdom, for his valuable efforts in discussing and framing the theoretical foundations of the research. Special thanks are also due to architect Saif Abou al—Naga, President of the Egyptian Architects Association, for his contributions to stimulating intellectual discussions during the preparation of the research.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Chaskin, R.J.; Joseph, M.L. Social interaction in mixed-income developments: Relational expectations and emerging reality. *J. Urban Aff.* **2011**, *33*, 209–237. [CrossRef]
2. Ofori, G. *Developing the Construction Industry in Ghana: The Case for a Central Agency*; National University of Singapore: Singapore, 2012. Available online: https://www.scirp.org/reference/referencespapers?referenceid=2895152 (accessed on 14 September 2024).
3. Alajizah, S.M.; Altuwaijri, H.A. Assessing the Impact of Urban Expansion on the Urban Environment in Riyadh City (2000–2022) Using Geospatial Techniques. *Sustainability* **2024**, *16*, 4799. [CrossRef]
4. Bowring, J.; Egoz, S.; Ignatieva, M. 'As good as the West': Two paradoxes of globalisation and landscape architecture in St. Petersburg. *J. Landsc. Arch.* **2009**, *4*, 6–15. [CrossRef]
5. Frantzeskaki, N.; Castán Broto, V.; Coenen, L.; Loorbach, D. (Eds.) *Urban Sustainability Transitions*, 1st ed.; Routledge: London, UK, 2019.
6. Fuenfschilling, L.; Frantzeskaki, N.; Coenen, L. Urban experimentation & sustainability transitions. *Eur. Plan. Stud.* **2018**, *27*, 219–228. [CrossRef]
7. Ameen, R.F.M.; Mourshed, M. Urban Sustainability Assessment Framework Development: The Ranking and Weighting of Sustainability Indicators Using Analytic Hierarchy Process. *Sustain. Cities Soc.* **2019**, *44*, 356–366. [CrossRef]
8. Wang, F.; Chen, J.; Tong, S.; Zheng, X.; Ji, X. Construction and Optimization of Green Infrastructure Network Based on Space Syntax: A Case Study of Suining County, Jiangsu Province. *Sustainability* **2022**, *14*, 7732. [CrossRef]
9. Yang, B.; Li, S.; Binder, C. A research frontier in landscape architecture: Landscape performance and assessment of social benefits. *Landsc. Res.* **2015**, *41*, 314–329. [CrossRef]
10. Hopkins, E.A. LEED Certification of Campus Buildings: A Cost-Benefit Approach. *J. Sustain. Real Estate* **2015**, *7*, 99–111. [CrossRef]
11. Asadi, S.; Farrokhi, M. The Challenges of Sustainable Development and Architecture. *Int. J. Sci. Technol. Soc.* **2015**, *3*, 11–17. [CrossRef]
12. Sassen, S. The Global City: Introducing a Concept. *Brown J. World Aff.* **2005**, *11*, 27–43. Available online: https://www.columbia.edu/~sjs2/PDFs/globalcity.introconcept.2005.pdf (accessed on 22 February 2024).
13. Evenden, L.J. The Vancouver Achievement: Urban Planning and Design. *Int. J. Urban Reg. Res.* **2006**, *30*, 236–238. [CrossRef]
14. Salama, A.; Alshuwaikhat, H. A Trans-disciplinary Approach for a Comprehensive Understanding of Sustainable Affordable Housing. *Glob. Built Environ. Rev. (GBER)* **2006**, *5*, 35–50.
15. Ding, G.K. Developing a Multicriteria Approach for the Measurement of Sustainable Performance. *Build. Res. Inf.* **2005**, *33*, 3–16. [CrossRef]
16. Dziekan, K. Evaluation of Measures Aimed at Sustainable Urban Mobility in European Cities–Case Study CIVITAS MIMOSA. *Procedia Soc. Behav. Sci.* **2012**, *48*, 3078–3092. [CrossRef]
17. Mohsin, M.M.; Beach, T.; Kwan, A. A review of sustainable urban development frameworks in developing countries. *J. Sustain. Dev.* **2023**, *16*, 1–19. [CrossRef]
18. Ghosh, S.; Vale, R.; Vale, B. Indications from Sustainability Indicators: Practice Note. *J. Urban Des.* **2006**, *11*, 263–275. [CrossRef]
19. Pardo, J.M.F. Challenges and Current Research Trends for Vernacular Architecture in a Global World: A Literature Review. *Buildings* **2023**, *13*, 162. [CrossRef]
20. Selim, H.S. Reactions to Architectural Globalization in the Context of Contemporary Cairo. *Int. J. Archit. Res. Archnet-IJAR* **2018**, *12*, 307–325. [CrossRef]
21. Thomson, C.S.; El-Haram, M.A. Is the evolution of building sustainability assessment methods promoting the desired sharing of knowledge amongst project stakeholders? *Constr. Manag. Econ.* **2018**, *37*, 433–460. [CrossRef]
22. Olander, S.; Landin, A. Evaluation of stakeholder influence in the implementation of construction projects. *Int. J. Proj. Manag.* **2005**, *23*, 321–328. [CrossRef]
23. Beaudrie, C.E.H.; Kandlikar, M.; Ramachandran, G. Chapter 5—Using Expert Judgment for Risk Assessment. In *Assessing Nanoparticle Risks to Human Health*, 2nd ed.; Ramachandran, G., Ed.; William Andrew Publishing: Norwich, NY, USA, 2016; pp. 91–119. ISBN 9780323353236. [CrossRef]
24. Ismail, G.; Taliep, N. The Delphi Method. In *Handbook of Social Sciences and Global Public Health*; Liamputtong, P., Ed.; Springer: Cham, Switzerland, 2023. [CrossRef]
25. Delbecq, A.L.; Van de Ven, A.H.; Gustafson, D.H. *Group Techniques for Program Planning: A Guide to Nominal Group and Delphi Processes*; Scott Foresman: Glenview, IL, USA, 1975. [CrossRef]
26. Hsu, C.-C.; Sandford, B. The Delphi Technique: Making Sense of Consensus. *Pract. Assess. Res. Eval.* **2007**, *12*, 10. [CrossRef]
27. Linstone, H.; Turoff, M. *The Delphi Method: Techniques and Applications*; Addison Wesley: Boston, MA, USA, 1975.
28. Saunders, B.; Sim, J.; Kingstone, T.; Baker, S.; Waterfield, J.; Bartlam, B.; Burroughs, H.; Jinks, C. Saturation in qualitative research: Exploring its conceptualization and operationalization. *Qual. Quant.* **2018**, *52*, 1893–1907. [CrossRef] [PubMed] [PubMed Central]
29. Bramley, G.; Power, S. Urban Form and Social Sustainability: The Role of Density and Housing Type. *Environ. Plan. B Plan. Des.* **2009**, *36*, 30–48. [CrossRef]

30. Fouseki, K.; Nicolau, M. Urban Heritage Dynamics in 'Heritage-Led Regeneration': Towards a Sustainable Lifestyles Approach. *Hist. Environ. Policy Pract.* **2018**, *9*, 229–248. [CrossRef]
31. Russell, P.; Redmond, D. Social housing regeneration in Dublin: Market-based regeneration and the creation of sustainable communities. *Local Environ.* **2009**, *14*, 635–650. [CrossRef]
32. Alvelos, H.; Barreto, S. Contributions towards a plurality in design narratives: Addressing dynamics between global and local discourses. *Des. J.* **2022**, *25*, 934–954. [CrossRef]
33. Boverket—The Swedish National Board of Housing, Building and Planning. Available online: https://www.government.se/government-agencies/boverket--the-swedish-national-board-of-housing-building-and-planning/ (accessed on 22 February 2024).
34. Shamaee, S.H.; Yousefi, H.; Zahedi, R. Assessing urban development indicators for environmental sustainability. *Discov. Sustain.* **2024**, *5*, 341. [CrossRef]
35. Goswami, R.; Saha, S.; Dasgupta, P. Sustainability assessment of smallholder farms in developing countries. *Agroecol. Sustain. Food Syst.* **2017**, *41*, 546–569. [CrossRef]
36. United Nations. *Indicators of Sustainable Development: Guidelines and Methodologies*, 2nd ed.; United Nations: New York, NY, USA, 2007.
37. Selim, H.S.; Mayhoub, M.S.; Abuzaid, A. A Comprehensive Model to Assess Sustainable Architecture in Emerged Megacities: A Closer Look at Cairo's New Administrative Capital (NAC). *Sustainability* **2024**, *16*, 5046. [CrossRef]
38. Jiang, B.; Li, H.; Dong, L.; Wang, Y.; Tao, Y. Cradle-to-Site Carbon Emissions Assessment of Prefabricated Rebar Cages for High-Rise Buildings in China. *Sustainability* **2019**, *11*, 42. [CrossRef]
39. Friedlingstein, P.; Jones, M.W.; O'Sullivan, M.; Andrew, R.M.; Hauck, J.; Peters, G.P.; Peters, W.; Pongratz, J.; Sitch, S.; Quéré, C.L.; et al. Global Carbon Budget 2019. *Earth Syst. Sci. Data* **2019**, *11*, 1783–1838. [CrossRef]
40. Alodah, A. Towards Sustainable Water Resources Management Considering Climate Change in the Case of Saudi Arabia. *Sustainability* **2023**, *15*, 14674. [CrossRef]
41. González-Martín, J.; Kraakman, N.J.R.; Pérez, C.; Lebrero, R.; Muñoz, R. A state-of-the-art review on indoor air pollution and strategies for indoor air pollution control. *Chemosphere* **2021**, *262*, 128376. [CrossRef] [PubMed]
42. What Is Zero Waste? Available online: https://ecocycle.org/learn-about-zero-waste/what-is-zero-waste/#:~:text=Zero%20Waste%20means%20designing%20and,not%20burn%20or%20bury%20them (accessed on 23 December 2020).
43. Marselle, M.; Hartig, T.; Cox, D.; de Bell, S.; Knapp, S.; Lindley, S.; Triguero-Mas, M.; Boehning-Gaese, K.; Cook, P.; de Vries, S.; et al. Pathways linking biodiversity to human health: A conceptual framework. *Environ. Int.* **2021**, *150*, 106420. [CrossRef] [PubMed]
44. Climate Group RE100. Available online: https://www.there100.org/#:~:text=RE100%20is%20a%20global%20initiative,established%20in%20partnership%20with%20CDP (accessed on 13 September 2023).
45. BREEAM. What Is BREEAM | Sustainable Building Certification. 2024. Available online: https://breeam.com/about/how-breeam-works#:~:text=A%20BREEAM%20assessment%20uses%20recognised,criteria%20from%20energy%20to%20ecology (accessed on 24 August 2024).
46. ASHRAE. *ASHRAE Handbook—Fundamentals*; Amer Society of Heating: Atlanta, GA, USA, 2020.
47. *ISO 14040:2006*; Environmental Management—Life Cycle Assessment—Principles and Framework. International Organization for Standardization: Geneva, Switzerland, 2006.
48. USGBC. LEED Certification for Neighborhood Development. Available online: https://www.usgbc.org/leed/rating-systems/neighborhood-development (accessed on 25 December 2023).
49. ILFI. Living Building Challenge. Available online: https://living-future.org/lbc/ (accessed on 24 August 2024).
50. DGNB. Nachhaltig Bauen Mit der DGNB. Available online: https://www.dgnb.de (accessed on 14 September 2024).
51. *GB/T51255-2017*; Assessment Standard for Green Eco-District. National Standard of the People's Republic of China: Beijing, China, 2017.
52. UN-Habitat. The Right to Adequate Housing. Available online: https://unhabitat.org/sites/default/files/documents/2019-05/fact_sheet_21_adequate_housing_final_2010.pdf (accessed on 14 September 2024).
53. *ISO 45001*; Occupational Health and Safety Management Systems. ISO: Geneva, Switzerland, 2018.
54. Global Reporting Initiative (GRI). *Consolidated Set of the GRI Standards 2021*; GRI: Amsterdam, The Netherlands, 2021. Available online: https://www.amauni.org/wp-content/uploads/2022/03/Set-of-GRI-Stnds-2021.pdf (accessed on 14 September 2024).
55. OECD. Civic Participation and Governance. In *How's Life?: Measuring Well-Being*; OECD Publishing: Paris, France, 2011. [CrossRef]
56. *ISO 14044:2006*; Environmental Management—Life Cycle Assessment—Requirements and Guidelines. International Organization for Standardization: Geneva, Switzerland, 2006.
57. *ISO 16283-2:2015*; Acoustics—Measurement of Sound Insulation in Buildings and of Building Elements—Part 2: Impact Sound Insulation. International Organization for Standardization: Geneva, Switzerland, 2014.
58. Oxley, E.; Nash, H.M.; Weighall, A.R. Consensus building using the Delphi method in educational research: A case study with educational professionals. *Int. J. Res. Method Educ.* **2024**, 1–15. [CrossRef]
59. Hwang, C.L.; Yoon, K. *Multiple Attribute Decision Making: Methods and Applications*; Springer: Berlin/Heidelberg, Germany, 1981.
60. Kibert, C.J. *Sustainable Construction: Green Building Design and Delivery*, 3rd ed.; John Wiley & Sons: Hoboken, NJ, USA, 2012.
61. Green Riyadh Project. Available online: https://www.rcrc.gov.sa/en/projects/green-riyadh-project (accessed on 14 September 2024).

62. Netherlands Enterprise Agency (RVO). Sustainable Building: A Guide to Sustainable Design Principles. Impact. 2020. Available online: https://english.rvo.nl/ (accessed on 25 August 2024).
63. Saudi Arabia's Financial Hub. Castles in the Air. *The Economist*, 30 January 2016. Available online: https://www.economist.com/middle-east-and-africa/2016/01/30/castles-in-the-air (accessed on 31 January 2023).
64. KPMG. Our Insights. Available online: https://kpmg.com/xx/en/our-insights.html (accessed on 22 December 2023).
65. Royal Commission for Riyadh City. Available online: https://www.rcrc.gov.sa/en/ (accessed on 16 August 2023).
66. HOK. Projects. Available online: https://www.hok.com/projects/ (accessed on 14 September 2024).
67. SOM. Designed Environments. Available online: https://www.som.com/ (accessed on 14 September 2024).
68. Foster + Partners. Projects. Available online: https://www.fosterandpartners.com/projects (accessed on 14 September 2024).
69. U.S. Green Building Council. LEED Certification Database: King Abdullah Financial District (KAFD). Available online: https://www.usgbc.org/ (accessed on 14 September 2024).
70. Omrania. KAFD Grand Mosque. Available online: https://omrania.com/project/kafd-grand-mosque/ (accessed on 14 September 2024).
71. ArchDaily. Zaha Hadid Architects Wins Competition for KAFD Metro Station in Riyadh. 2019. Available online: https://www.archdaily.com/374198/zaha-hadid-architects-selected-to-design-the-king-abdullah-financial-district-metro-station-in-saudi-arabia-2 (accessed on 14 September 2024).
72. Zaha Hadid Architects. KAFD Metro Station. Available online: https://www.zaha-hadid.com/architecture/king-abdullah-financial-district-metro-station/ (accessed on 14 September 2024).
73. KAPSARC. Available online: https://www.kapsarc.org/ (accessed on 23 September 2023).
74. Yi, T.; Yun, S. Saudi Arabia's LEED Projects: Recent Green Building Trends and Perspective. *IOP Conf. Ser. Earth Environ. Sci.* **2022**, *1026*, 012062. [CrossRef]