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Integrated Framework for Enhancing Liveability and Ecological Sustainability in UAE Communities

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Abstract: Urban growth is vast in the United Arab Emirates (UAE) due to economic development, and there is a need to consider liveability and sustainable ecosystems for future urban expansion. Promising strategies for sustainability focus on minimizing a building's effects on the environment and improving residents' quality of life, which is important in the desert and when confronting the issues of water and climate change. Sustainable practices that impact the livelihood of people in the UAE include factors such as walkable areas, open space, policing, healthcare, education, housing, and ensuring friendly transport that enhance the overall quality of life of residents in the region. Recognizing and appreciating the UAE's cultural values is crucial when incorporating these aspects, allowing references to the nation's character when creating communal areas. The primary research included quantitative surveys of three identified communities, composed of fifty participants each, where the findings indicate partial to full compliance, with 85.7% of the liveability indices being about public transport and green space. Through this analysis, liveability and sustainability principles need to be trialed and incorporated into future urban development to embrace the ecology as well as the inhabitants. To realize these targets, the proposed study adopted a four-part approach. Initially, an analysis of related studies concerning the UAE or the Gulf area was carried out to obtain important liveability and quality-of-life factors. A total of 6 dimensions and 51 indicators were extracted from the literature to inform the next stage. Subsequently, the authors identified and evaluated the design of three chosen communities in various cities in the UAE concerning liveability and sustainability indices. Consequently, a conceptual redesign of a typical community was made, illustrating the improved quality of life and sustainability. Lastly, a survey with respective facets from an urban planning architect and environmental scientist cum environmental economist was conducted to evaluate the practicality of the proposed design. This research gives a comprehensive picture of how liveability and sustainable ecosystem concepts need to be implemented in the UAE urban context and offers a direction to develop lively, context-specific, culturally attached, and sustainable urban environments for the present day and for the future.

Keywords: liveability; housing community; UAE; quality of life; residential community; sustainable ecosystem

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1. Introduction

Many developing cities experience similar problems, especially associated with high population growth and intensive development of the economy. Such challenges result in forces or pressures that hasten change in the use of land to support increased demand for housing, shopping, and company production. Various changes, affected by the previous year's urban growth, in arid and semi-arid regions in terms of landscape, spatial pattern, and ecological characteristics have a high influence on the current state of urban ecosystems and the sustainable use of natural resources [1]. This issue is especially common in the

desert and dry subsisting areas, most commonly within the Persian Gulf Region. Major environmental constraints including cyclic drought, heat, dust storms, and a shortage of water sources may have limited development and particularly urban growth in these areas, but technology has begun to make a difference. Some of the developed innovative areas that have contributed to city growth in the UAE include desalination, food supply chain management, intensive air conditioning, and an extensive road network, among others [2].

However, while these artificial living environments delineate solutions that can be implemented across the urban world, there are also further requirements for finite evaluations of the living standards they offer and the absent ecological effects of such environments. Landscapes are increasingly under anthropogenic pressure, fauna and flora are decreasing, deforestation processes are growing, climate change is occurring, and floods remain a threat. The increase in demand for the development of urban infrastructure in these deserts has the potential to degrade ecosystem services, accelerating the reduction in biodiversity, vegetation cover, hydrology, food security, and more general livelihoods in arid regions of the globe including the UAE [2]. Minimizing changes in natural environments due to the rapid growth of towns and cities remains a challenge, and the risks associated with the effects on biodiversity require detailed environmental and ecological impact assessments. These include field surveys, the Ecological Environment Quality Index, and quantitative ecological models, which are needed to determine the effects that urbanization has on ecological systems [3]. When it comes to the growth of cities, especially in the UAE, the use of ecological and environmental assessments is important when planning the cities. These assessments should be incorporated into the feasibility studies of large-scale development projects such as housing communities, which are quickly emerging in the UAE. Through the application of expert evaluation methods, policymakers will be able to obtain in-depth insights into the likely impacts of urban development to measure human needs with sustainability [3,4]. The requirement for the construction of purposeful urban design is significantly more than it was previously, especially in areas in which the sustainability of a community is vulnerable to slight shifts in the delicate balance of the ecosystem with the unprecedented rate of exploitation.

The concept underpins sustainable urban design and is not limited to simply designing environmentally friendly living structures. It deals with a comprehensive design that takes account of nature so that ecosystems can be maintained even though a collaborative environment is created for the habitation of humans and animals. In the UAE, the design of liveable sustainable communities must also incorporate culture into the process. Meeting the social requirements of the UAE population's needs with green areas, pedestrian and cycling facilities, public transportation, availability of education, and healthcare, while still incorporating the cultural and historical background of the United Arab Emirates, is key to making urban expansion viable and sustainable while addressing environmental concerns [4]. Examining the Persian Gulf as a case study of rapid urbanization applied to desert environments such as that present in the UAE, it is clear that there are both potential benefits and potential problems. Thus, despite technological capabilities to support mega-populations in these environments, urbanization brings considerable environmental challenges. Seeking approval on future development projects' sustainability without first conducting an impact assessment or considering the U.S EPA principles and guidelines results in misleading and unsustainable scenarios for developing future projects. Overall, the general aim of this research is to analyze the impact of urbanization on ecosystem sustainability as well as the liveability of the districts within the context of the UAE.

2. Literature Review

Human activities affect the natural environment and cause its decline through impacts on habitats, forests, and the climate, including floods. The indicated extensive violations of the desert ecosystem for development requirements jeopardize the habitat, species richness, vegetation cover, water supply, food availability, and living standards in arid zones, including the UAE, and will continue to do so in the future [2]. Many students consider

rapid urbanization, through the development of the towns and cities, as dangerous for the fauna and flora. Therefore, basic environmental and ecological impact assessments are necessary to determine such effects. These include cross-sectional surveys, ecological asset rating systems such as the Ecological Environment Quality Index (EEQI) and the Remote Sensing Ecological Index (RSEI), and ecological modeling through index numbers [2]. Such methodological techniques can be of help when evaluating the effects of urbanization on the environment at large and should therefore form part of large-scale developments such as housing in the UAE as part of feasibility studies.

Specifically, in recent years, some UAE community developments have raised questions on how they meet liveability standards. Liveability is a complex and evolving concept that measures the rankings of urban places based on elements of community well-being, social inclusion, cultural and recreational facilities, employment opportunities, and levels of economic development. They include physical infrastructure, accessibility, and also the design of the physical environment as a practical place. Environmental sustainability is the other core area and it deals with issues related to air quality; well-developed green areas; and the prudent use of natural resources [4–6].

Urban design is a subdiscipline of urban planning and can be defined as the design of public spaces in urban areas. It defines the processes of changing the appearance of cities, towns, and villages to develop graphic, useful, and environmentally friendly surroundings. Architecture, engineering, landscape design, public policy, and other disciplines are involved in urban design, so synergy is critical [7]. Most important in urban planning and design, liveability defines viable built environments based on people's needs. For instance, the place-making cities offer easily accessible accommodations more people can afford, which enhances diversity and gives a home to people from different backgrounds. Public transportation systems are considered essential; they ease traffic, and environment decongestion as well as help with mobility and social inclusion. Playgrounds are as important as green areas because they make the environment look beautiful and they afford people a chance to exercise physically and mentally. These elements point out that the planning and designing of cities require a focus on overall community health in the provision of education, healthcare facilities, culture, and economic opportunities [4–6,8].

An analysis of liveability is necessarily qualitative since liveability is a subjective concept. A liveable city can be defined in various ways due to different perceptions that different people have due to taste, culture, and situation. This, therefore, poses a problem and at the same time a strength because of the encouragement that urban planners need to interact with people to understand these different perspectives. However, the use of the LA (liveability assessment) index or any set of standardized liveability indicators can offset this by trying to view liveability from a third-person perspective. These indicators, such as access to economic opportunities, social diversity, affordability, and health and safety, allow urban planners to base decisions on measurable factors. Quantifying liveability aspects facilitates data-driven urban planning that benefits the entire community. Incorporating objective indicators early in the design process provides urban planners with the potential to guide policy, set goals, and achieve data-informed urban development [9–11].

Liveability assessments are essential for enhancing the quality of life within residential communities. These communities share many characteristics with urban environments, such as housing, infrastructure, and communal spaces. Therefore, liveability indicators applied to urban areas are also relevant to residential communities. Liveability assessments evaluate key aspects of residential life, including housing conditions, shared spaces, transportation, and community services.

Several studies have addressed the liveability and sustainability of UAE communities. For instance, a study of the Al Waha community in Dubai by Litman in 2010 identified deficiencies in land-use diversity, accessibility, walkability, landscaped areas, and building design diversity. These elements could be improved by focusing on enhancing land-use diversity, accessibility, walkability, building height diversity, and green areas [12]. However, this study only analyzed one district within one emirate and did not assess the effects of

improving liveability on the surrounding natural ecosystem or the potential impacts of climate change.

Another study on Sharjah's Sustainable City by Shareef and Altan in 2021 employed the Analytical Hierarchy Process (AHP) to prioritize key factors for creating a sustainable city. It found that energy-efficient building design, public transportation-oriented development, and the use of renewable energy (e.g., solar, geothermal, and wind) were of the highest priority, while greening strategies (green roofs, walls, and artificial ground) and water circulation systems were given lower priority [13]. However, this study also focused on one city and did not explore the relationship between enhancing liveability and its effect on the natural ecosystem.

A study on housing affordability in Dubai communities by Alawadi et al. in 2018 provided insights into housing patterns and rental affordability. It recommended policies such as impact mitigation fees and rent control [14], but this study focused on affordability without assessing other aspects of liveability. Similarly, another study on 13 Dubai communities by Ali et al. in 2023 assessed walkability and found that service distribution and walkability infrastructure outside the studied areas required development [15]. Like the previous studies, it did not address a comprehensive range of liveability indicators.

Overall, liveability assessment is essential in aiding the design and construction of housing communities and remains a priority for both researchers in academia and industry experts in order to aid the design and construction of attractive liveable housing communities. However, most of the performed studies have only addressed one aspect of liveability or were limited to one geographic area within the UAE. To date, there are no comprehensive studies that assess the liveability of local housing communities in the UAE by assessing residential communities from multiple cities. Moreover, no reported work has addressed liveability by assessing residential communities through subject matter experts' technical evaluation, nor did they propose actual design enhancements that address the relationship between liveability enhancement and the natural ecosystem of the UAE and the possible impacts on climate change. Therefore, this study is going to fill this gap and provide a comprehensive assessment that will benefit academia and industry experts in the future design and construction of liveable housing communities in the UAE.

Quality-of-life indices such as the ones developed by the Economist Intelligence Unit (EIU) and Mercer are widely used to assess liveability in different cities and regions. For example, the EIU Global Liveability Index ranks cities based on stability, healthcare, culture, education, and infrastructure, providing a comparative measure of overall liveability. These rankings are invaluable for urban planners and policymakers when evaluating and comparing the attractiveness and quality of life in various cities worldwide. Similarly, Mercer's Quality of Living Reports consider factors like political stability, healthcare, education, and safety to assess the quality of life in cities, aiding multinational corporations in determining compensation packages for employees stationed in different locations. Moreover, city officials and planners can utilize Mercer's reports to identify areas where improvements are necessary to enhance the liveability of their urban areas, making them more appealing to talent and investment. In addition to these, several other index frameworks, such as the OECD Better Life Index, Numbeo Quality of Life Index, Urban Liveability Index (ULI), AARP Liveability Index, Monocle Quality of Life, and City Quality of Life Index (CityQOL), offer diverse perspectives on liveability, each contributing to a more comprehensive understanding of the factors that influence the quality of life in cities and regions. Table 1 below summarizes and compares aspects of QoL identified by different indices [16–22].

A preliminary list of indicators was proposed after reviewing the literature in Table 2 below. The process of developing key performance indicators (KPIs) to assess the liveability of residential communities is rooted in a rigorous and comprehensive literature review that spans various disciplines. This extensive exploration aims to synthesize a holistic framework capable of capturing the multifaceted nature of residential liveability.

Table 1. Summary of indices used to assess quality of life (QoL).

AARP	Mercer	EIU	OECD	Numbeo Quality of Life	Urban Liveability Index (ULI)	Monocle's Quality of Life	City Quality of Life Index (CityQOL)
Housing	Housing	Stability	Housing	Cost of living	Social infrastructure	Culture and environment	Economic development
Neighborhood	Economic environment	Healthcare	Income	Safety	Walkability	Public transport	Social security
Transportation	Transportation	Culture and Environment	Jobs	Healthcare	Public transport	Healthcare	Public services
Environment	Environment	Education	Community	Pollution	Public open space	Business conditions	Environmental quality
Health	Health	Infrastructure	Education	Climate	Housing affordability	Safety/crime	Transportation
Civic Engagement	Education		Environment	Traffic	Local employment	Recreation	Housing
Social Engagement	Security		Civic engagement	Quality of life		Tolerance	Education
Opportunity	Public services		Health			Pro-active policy	Medical care
	Sports		Life satisfaction			Nature	Culture and leisure
	Political and social		Safety				Urban security
	Recreation		Work–life balance				
	Consumer goods		Housing				
			Income				

Table 2. List of preliminary indicators extracted through literature review.

Indicator per Dimension	Reference
Infrastructure and Accessibility	
Bikeability	[23–26]
Public transportation access and coverage	[16,27–29]
Proximity to essential amenities (e.g., grocery stores, healthcare)	[18,30–33]
Pedestrian-friendly infrastructure (e.g., sidewalks, crosswalks)	[34–36]
Accessibility of housing units for people with disabilities	[18,37,38]
Access to high-quality schools and educational institutions	[33,38]
Availability of broadband internet access	[39,40]
Well-maintained streets	[23,24,41]
Access to quality public services (e.g., waste collection, public parks)	[16,27–29]
Housing	
Housing affordability (median housing cost relative to income)	[6,42,43]
Housing quality and maintenance standards	[44–46]
Housing density, indicating the number of housing units per acre	[47–50]
Sense of privacy in dwelling units	[47,51,52]
Utility costs	[6,42,43]
Architectural diversity and design quality	[16,53]
Availability of mixed-use developments that blend housing with commercial and recreational spaces	[54–56]
Housing diversity (variety of housing types and sizes)	[16,53]
Availability of parking	[16,53]
Environmental Quality and Sustainability	
Tree canopy cover	[6,18,57]
Availability of affordable housing units designed to be sustainable and energy-efficient	[6,42,43]
Renewable energy usage	[58–60]
Recycling and waste management programs	[58,59,61]
Landscaping	[18,62,63]
Outdoor lighting	[44,64,65]
Street maintenance/cleanliness	[25,51,66]
Green building practices and sustainable design	[58,59,67]
Green space percentage, indicating the amount of greenery and parks	[68–70]

Table 2. *Cont.*

Indicator per Dimension	Reference
Health and Well-being	
Access to healthcare facilities and healthcare quality	[4,33,71]
Availability of healthy food options to support healthy eating habits	[4,72,73]
Availability of well-maintained parks and recreational areas designed to promote physical activity	[74–76]
Spaces for relaxation and stress relief	[74–76]
Community spaces and design elements that encourage social interaction and unneighborly relations	[66,77,78]
Public safety features integrated into the urban design, such as well-lit pathways and emergency response infrastructure	[18,79,80]
Mental health support services and counseling resources	[81–83]
Cultural and Recreational Opportunities	
Access to theaters, museums, and libraries	[81,84,85]
Recreational facilities (e.g., parks, sports centers)	[16,25,66–68]
The presence of community centers and gathering spaces	[66,77,78]
Access to dining and shopping options	[16,86,87]
Places of worship	[18,88,89]
Integration of street art and public art installations, fostering community identity	[53,90]

The first dimension, infrastructure and accessibility, places a strong emphasis on ensuring that a residential community is well connected and accessible. This dimension encompasses a range of KPIs that focus on different aspects of accessibility and convenience. Bikeability assesses the availability of dedicated cycling infrastructure, promoting eco-friendly transportation and physical activity. Public transportation access and coverage consider the extent to which residents can rely on public transit, reducing car dependency and supporting mobility. Proximity to essential amenities evaluates how conveniently residents can access necessities such as grocery stores and healthcare facilities. Pedestrian-friendly infrastructure examines the presence of sidewalks and crosswalks, which are critical for ensuring safe walkability within the community. The availability of bike lanes and cycling infrastructure encourages biking as a sustainable mode of transportation. Accessibility of housing units for people with disabilities underscores the importance of inclusivity and equal access for all community members. Access to high-quality schools and educational institutions recognizes the pivotal role of education in community well-being. Lastly, the presence of broadband internet access acknowledges the increasing importance of connectivity in modern life. Well-maintained streets and the quality of public services like waste collection and public parks also contribute significantly to the overall functionality and liveability of the community [10,12,17–33].

The housing dimension plays a pivotal role in evaluating residents' comfort and overall well-being within a community. Central to this dimension is housing affordability, which assesses the reasonableness of housing costs relative to residents' incomes, ensuring accessibility. Moreover, housing quality and maintenance standards emphasize habitability, comfort, and safety, while housing density impacts the sense of space and community. Privacy within dwelling units acknowledges personal space's significance for residents' well-being, while utility costs evaluate affordability and sustainability. Architectural diversity and design quality enhance esthetics and create a visually appealing environment. Mixed-use developments foster dynamic communities, and housing diversity caters to various preferences, ensuring residents' needs are met. Additionally, the availability of parking spaces enhances daily convenience and accessibility, collectively shaping the residential experience [3,10,34–41].

The environmental quality and sustainability dimension prioritizes the ecological well-being of the community, with KPIs aimed at assessing environmental consciousness and sustainability. Notably, indicators such as tree canopy cover and green space percentage demonstrate the presence of greenery, offering ecological advantages such as enhanced air quality, temperature regulation, and improved overall well-being. Moreover, the inclusion of affordable housing units designed for sustainability and energy efficiency encourages eco-

friendly living, reducing the community's carbon footprint. Metrics related to renewable energy usage and recycling programs reflect the community's commitment to sustainable practices and minimizing its environmental impact. Well-maintained landscaping and outdoor lighting contribute to both esthetics and safety, while street maintenance and cleanliness bolster overall environmental quality, improving the community's overall appeal. Additionally, the incorporation of green building practices and sustainable design upholds eco-friendly construction standards, fostering environmentally conscious building practices. The percentage of green space within the community symbolizes the extent of open, natural areas, further enhancing residents' well-being and supporting the ecological health of the area [3,12,34–36,38,42–46].

Within the health and well-being dimension, the primary focus centers on residents' holistic well-being, encompassing physical and mental health, along with overall quality of life. To achieve this, an array of interconnected KPIs is established. Access to healthcare facilities and healthcare quality ensure residents can readily obtain essential medical services while receiving high-quality care. The presence of healthy food options, such as grocery stores and/or restaurants, supports proper nutrition and encourages healthy eating habits. Furthermore, well-maintained parks and recreational areas offer opportunities for physical activity and relaxation, thereby fostering a healthier lifestyle. Spaces designed for relaxation and stress relief are integrated to enhance residents' mental well-being, providing serene settings for peaceful reflection. Additionally, community spaces and design elements that promote social interaction and neighborly relations contribute to social health and a sense of belonging. To bolster safety and peace of mind, public safety features like well-lit pathways and emergency response infrastructure are incorporated. Finally, the provision of mental health support services underscores the community's commitment to addressing psychological well-being, ensuring residents have access to vital mental health resources and support systems [1,12,47–50].

The cultural and recreational opportunities dimension of residential liveability enhances residents' lives beyond their basic needs. These interconnected KPIs are designed to assess the community's cultural vibrancy and recreational offerings comprehensively. Residents' access to theaters, museums, and libraries enriches cultural engagement, fostering opportunities for learning and artistic appreciation. Recreational facilities, including parks and sports centers, provide space for physical activity and leisure, positively impacting residents' overall well-being. Furthermore, the presence of community centers and gathering spaces creates a sense of unity and offers venues for residents to come together, strengthening the community's social fabric. Access to dining and shopping options not only adds vibrancy to daily life but also enhances convenience, making the community appealing to both residents and visitors alike. Places of worship cater to diverse spiritual needs, serving as spaces for spiritual growth and community engagement. Lastly, the integration of street art and public art installations contributes to the creation of a unique community identity, showcasing local talent and enriching the area's esthetics and cultural richness [10,12,40,49,50]. These dimensions collectively provide a comprehensive framework for evaluating the liveability of residential communities, taking into account various facets that contribute to residents' well-being and overall quality of life.

Based on the literature review, previous studies have only addressed liveability within one city/emirate in the UAE, and only focused on specific indicators separately, such as affordability or location, but did not include a comprehensive assessment of all dimensions and indicators of liveability. Also, some studies have addressed the technical elements involving the design of housing communities and their adherence to liveability indicators, but only through simulations, and did not include a critical analysis of the relationship between enhancing the liveability of housing communities and the impact on the natural ecosystem of the UAE and climate change. Therefore, the proposed research aims to enhance the liveability and quality of life in UAE local housing communities through a systematic analysis of parameters and a redesign proposal. Accordingly, the objectives of this research are to identify and prioritize key parameters affecting liveability in local housing commu-

nities in the UAE, to analyze current local community plans and assess their alignment with liveability parameters and ecosystem sustainability, to propose redesign solutions for typical communities to enhance liveability and ecosystem conservation, to visualize potential improvements in community layouts and their impact on local ecosystems, to validate proposed enhancements through expert analysis, with a focus on their ecological implications, and to discuss the relationship between enhanced liveability of local housing communities, the natural ecosystem of the UAE, and the impacts on climate change. As a result, this research is going to be a novel contribution to the body of literature and will add significant value to experts in the field of construction and architecture. To explain, there is no previous research addressing the applicability of liveability indicators to local housing communities within the United Arab Emirates from a comprehensive perspective that tackles multiple cities in the country and provides real redesign proposals. Therefore, this research will benefit from the contribution of a panel of experts from the construction industry in validating the findings of the literature review and the redesign stage to provide a clear understanding of liveability in housing communities and aid in conducting future similar projects. Also, this research will have the added value of providing a critical analysis of methods to enhance the liveability of housing communities and the relationship between the natural ecosystem and climate change.

3. Materials and Methods

The research methodology was intricately structured (Figure 1), encompassing several key steps meticulously executed to ensure a comprehensive investigation into the liveability and quality-of-life aspects within the context of a chosen conceptual design in the UAE.

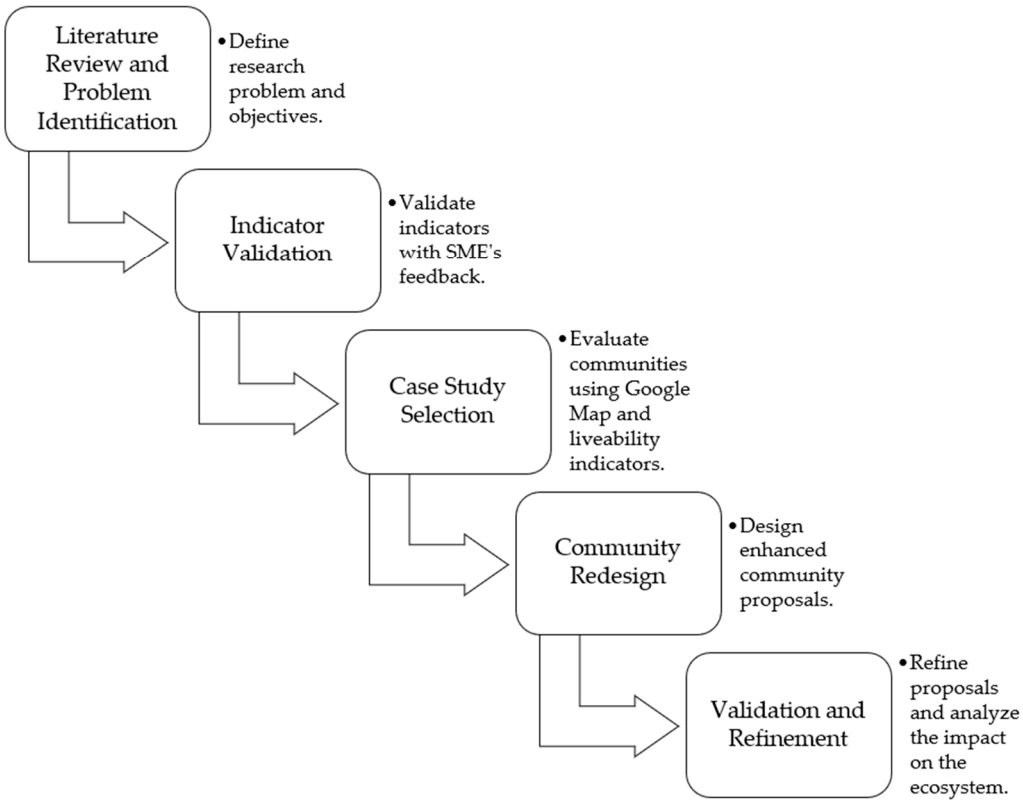


Figure 1. Research methodology flowchart.

3.1. Literature Review and Problem Identification

This study commenced with an extensive review of the existing literature, allowing for a thorough exploration of relevant studies to establish a solid foundation for the research by identifying a preliminary list of indicators used to assess liveability and quality of life

in housing communities based on several quality-of-life indices reported in the literature. Subsequently, the identification of research gaps within the literature became imperative, paving the way for precise articulation of the research problem and formulating clear research aims and objectives.

3.2. Indicator Validation with Subject Matter Experts (SMEs)

To validate the deduced indicators from the literature review, interviews were conducted with a total of 15 experts from three main professional sectors: 5 key specialists in architecture, 6 in construction, and 4 in urban planning. This purposive sample was used because the participants recruited had to have at least five years of experience in their fields of specialty so that the information elicited would be grounded on adequate experience. With such an expert distribution, it was possible to provide a sound approach to such issues since multiple liveability indicators in the development of housing communities can be identified.

3.3. Case Studies of UAE Housing Communities

The case studies were selected from three emirates out of seven in the UAE, owing to their varied typology and typicality: Khalifa City in Abu Dhabi, Al Barsha 3 in Dubai, and Al Darari in Sharjah. These communities were chosen based on the perceived urban layout, preferred by residents, and the environment they are located, thus representing the spread of the UAE's geography (Table 3). This selection makes it possible to generalize the findings to the other types of residential areas, including those lying in the coastal and desert regions, therefore yielding an overall liveability index.

Table 3. Selection criteria for analyzed communities.

Community	Emirate	Selection Criteria	Environmental Context	Relevance to Study
Khalifa City	Abu Dhabi	Popular residential area with typical urban design and community infrastructure	Coastal desert environment	Represents residential development in Abu Dhabi
Al Barsha 3	Dubai	Commonly inhabited, well-structured residential area with modern infrastructure	Urban metropolis with high development rate	Reflects urban growth and housing trends in Dubai
Al Darari	Sharjah	Typical residential neighborhood with similar characteristics to adjacent areas	Suburban region with desert surroundings	Exemplifies Sharjah's residential layout and urban planning trends

3.4. Enhanced Design Proposal and Validation

The following stage included the redesign proposal through collaboration with designers and urban planners to formulate an innovative solution for enhancing liveability and quality of life in similar residential communities to the ones chosen in this study while taking into account liveability and ecosystem preservation and incorporating the validated indicators. In addition to that, by employing design tools and techniques, visual representations were crafted to illustrate the proposed community improvements and their potential impact on ecosystems. Afterward, the redesign solutions and the initial case study assessments were verified through in-depth analysis by a total of seven subject matter experts who were distributed as follows: 14% from public/government entities supervising construction projects, 14% representing contractors responsible for residential projects, and 71% representing consultants, including architects and civil engineers. This validation provides a layer of credibility to the proposed enhancements from a practical industry-based point of view. Building on these insights, the conceptual redesign was refined, aligning it with the validated results. The last concluding step included an analytical discussion on the link between enhancing the liveability of residential communities, ecosystem sustainability, and mitigating climate change.

4. Results

This section highlights the main results obtained during each phase of the research as follows.

4.1. Validation of Indicators Through Subject Matter Experts (SMEs)

4.1.1. Expert Demographics

A total of ten experts were approached to participate in validating the preliminary list of indicators mentioned in Table 2. All experts consented to participate in the interview, where they had to complete an electronic form consisting of two sections: the first section included information about their demographics, and the second section listed the dimensions of liveability, with their respective indicators. Accordingly, Table S1 in File S1 provides an overview of the demographic details of the interviewees.

The majority of interviewees, making up 67%, belonged to the consultant category, followed by contractors, real estate professionals, and public sector representatives, each comprising 11% of the total. This distribution aligns with expectations, as consulting firms typically play a central role in the design and conceptualization of residential housing communities, while contractors, real estate entities, and public stakeholders are key implementers and supporting contributors throughout the process. Furthermore, 78% of the participants possessed 10 to 20 years of experience in the construction industry, with the remaining 22% having over 30 years of experience. This meets the sampling requirement, which mandated a minimum of 5 years of experience in the construction industry for subject matter experts. Such criteria ensured that the insights gathered would be most valuable in assessing the impact of implementing liveability indicators on the enhancement of residential housing community quality of life. In addition, out of the nine experts, only 22% had involvement in more than 20 projects related to urban planning, construction, and housing communities. Meanwhile, 44% of experts had participated in fewer than 10 projects, and the remaining 33% had experience in 10 to 20 projects. These data highlight the increasing need for residential housing communities and the high demand for such projects within the construction industry, which in turn draws more companies into the market and presents a potential for benefiting them with innovative designs and concepts to enhance the liveability of residential housing communities.

4.1.2. Finalization of Indicator List

Upon interviewing the subject matter experts, the preliminary list of liveability indicators was evaluated, with suggestions for additional indicators, as explained in Table 4 below.

Table 4. The final list of preliminary indicators extracted through the literature review and validated by subject matter experts, with additional suggested indicators from the experts (in bold).

Dimension	Indicators	Description
Infrastructure and **Accessibility**	Bikeability and biking lane availability	The availability of dedicated cycling infrastructure promotes eco-friendly transportation and physical activity and encourages biking as a sustainable mode of transportation
	Public transportation access and coverage	The extent to which residents can rely on public transit, reducing car dependency and supporting mobility
	Proximity to essential amenities (e.g., grocery stores, healthcare)	How conveniently residents can access necessities such as grocery stores and healthcare facilities
	Pedestrian-friendly infrastructure (e.g., sidewalks, crosswalks)	The presence of sidewalks and crosswalks, which are critical for ensuring safe walkability within the community
	Accessibility of housing units for people with disabilities	The importance of inclusivity and equal access for all community members
	Access to high-quality schools and educational institutions	Recognizes the pivotal role of education in community well-being
	Availability of broadband internet access	Acknowledges the increasing importance of connectivity in modern life
	Well-maintained streets **Access to quality public services (e.g., waste collection, public parks)**	Including waste collection and public parks that contribute significantly to the overall functionality and liveability of the community

Table 4. *Cont.*

Dimension	Indicators	Description
Housing	Housing affordability (median housing cost relative to income)	Reasonableness of housing costs relative to residents' incomes, ensuring accessibility
	Housing quality and maintenance standards	Emphasize habitability, comfort, and safety.
	Housing density, indicating the number of housing units per acre	Impacts the sense of space and community
	Sense of privacy in dwelling units	Acknowledges personal space's significance for residents' well-being
	Utility costs	Evaluate affordability and sustainability
	Architectural diversity and design quality	Enhance esthetics and create a visually appealing environment
	Availability of mixed-use developments that blend housing with commercial and recreational spaces	Foster dynamic communities
	Housing diversity (variety of housing types and sizes)	Caters to various preferences, ensuring residents' needs are met
	Availability of parking	Enhances daily convenience and accessibility, collectively shaping the residential experience
	Electric charging station/car chargers	Catering to the diverse needs of residents and reducing carbon emissions
Environmental Quality and Sustainability	Tree canopy cover	The presence of greenery offers ecological advantages such as enhanced air quality, temperature regulation, and improved overall well-being
	Availability of affordable housing units designed to be sustainable and energy-efficient	Encourages eco-friendly living, reducing the community's carbon footprint
	Renewable energy usage	Reflect on the community's commitment to sustainable practices and minimizing its environmental impact
	Recycling and waste management programs/selective waste collection	
	Landscaping	Contribute to both esthetics and safety
	Outdoor lighting	
	Street maintenance/cleanliness	Bolsters overall environmental quality and improves the community's overall appeal
	Green building practices and sustainable design	Upholds eco-friendly construction standards, fostering environmentally conscious building practices
	Green space percentage, indicating the amount of greenery and parks	Symbolizes the extent of open, natural areas, further enhancing residents' well-being and supporting the ecological health of the area
	Measurable parameters of the effort to save energy (CO_2 saved, trees saved, etc.)	
	Sound, light, and air pollution mitigation	
	Use of sustainable elements like solar PVs	
Health and Well-being	Access to healthcare facilities and healthcare quality	Ensures residents can readily obtain essential medical services while receiving high-quality care
	Availability of healthy food options	Supports proper nutrition and encourages healthy eating habits
	Availability of well-maintained parks and recreational areas designed to promote physical activity	Offers opportunities for physical activity and relaxation and fosters a healthier lifestyle
	Spaces for relaxation and stress relief	Provide serene settings for peaceful reflection and enhance residents' mental well-being
	Community spaces and design elements that encourage social interaction and unneighborly relations	Promote social interaction and contribute to social health and a sense of belonging
	Public safety features integrated into urban design, such as well-lit pathways and emergency response infrastructure	Bolster safety and peace of mind (well-lit pathways and emergency response infrastructure)
	Mental health support services and counseling resources	Addressing psychological well-being and ensuring residents have access to vital mental health resources and support systems
Cultural and Recreational Opportunities	Access to theaters, museums, and libraries	Enriching cultural engagement and fostering opportunities for learning and artistic appreciation
	Recreational facilities (e.g., parks, sports centers)	Including parks and sports centers to provide space for physical activity and leisure and positively impacts residents' overall well-being
	The presence of community centers and gathering spaces	Creating a sense of unity and offering venues for residents to come together to strengthen the community's social fabric
	Access to dining and shopping options	Adds vibrancy to daily life and enhances convenience
	Places of worship	Spaces for spiritual growth and community engagement (mosque, church, religious education center)
	Integration of street art and public art installations, fostering community identity	Creation of a unique community identity, showcasing local talent and enriching the area's esthetics and cultural richness
	Sport activities	Availability and accessibility of public spaces for sports (football, basketball, tennis stadiums, swimming pools)

4.2. Evaluation of Current Housing Communities in the United Arab Emirates

Three housing communities from Abu Dhabi, Dubai, and Sharjah were chosen for this study based on visual appearance and similarity to other adjacent communities. A summary of all the features of the evaluated neighborhoods can be found in File S2. Figures 2–4 show the location of each chosen community as obtained via Google Maps.

1. Case Study 1 (Khalifa City community, Abu Dhabi).

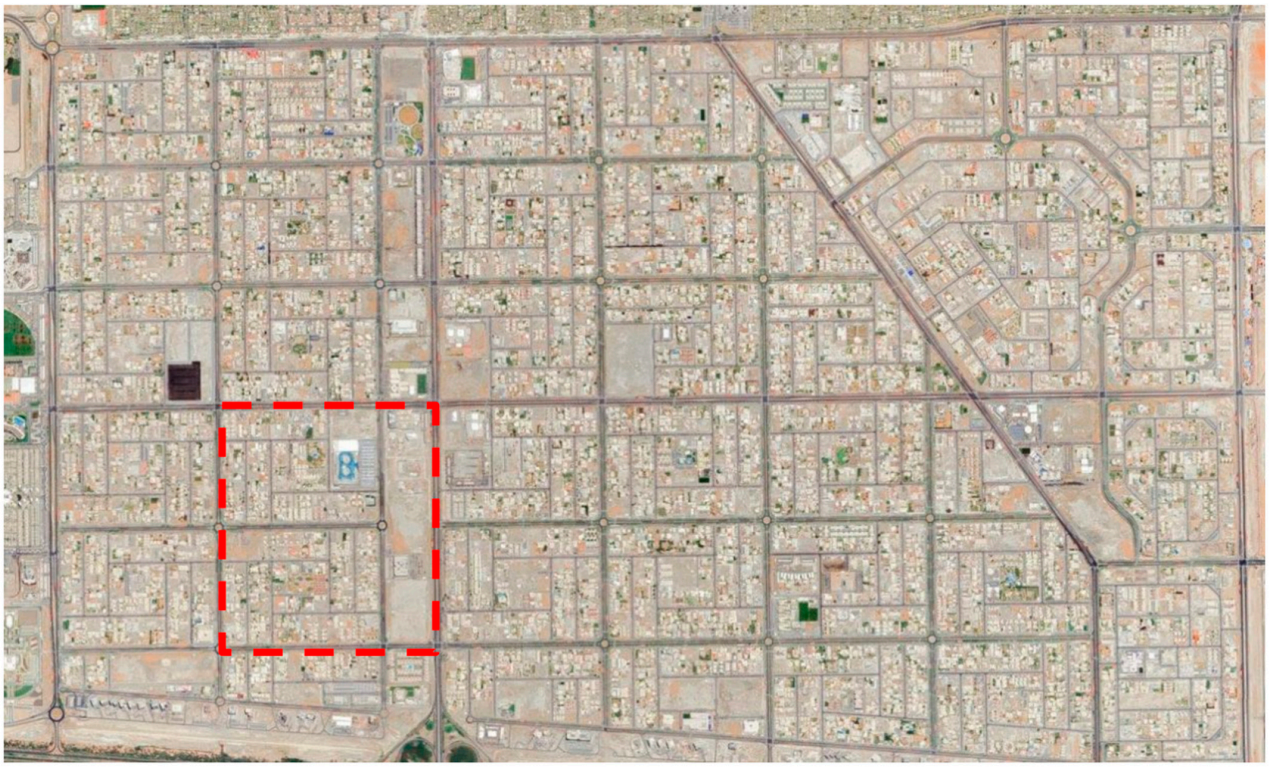


Figure 2. Snapshot of Khalifa City community in Abu Dhabi. The red box indicates the perimeter of the study community.

2. Case Study 2 (Al Barsha 3 in Dubai).

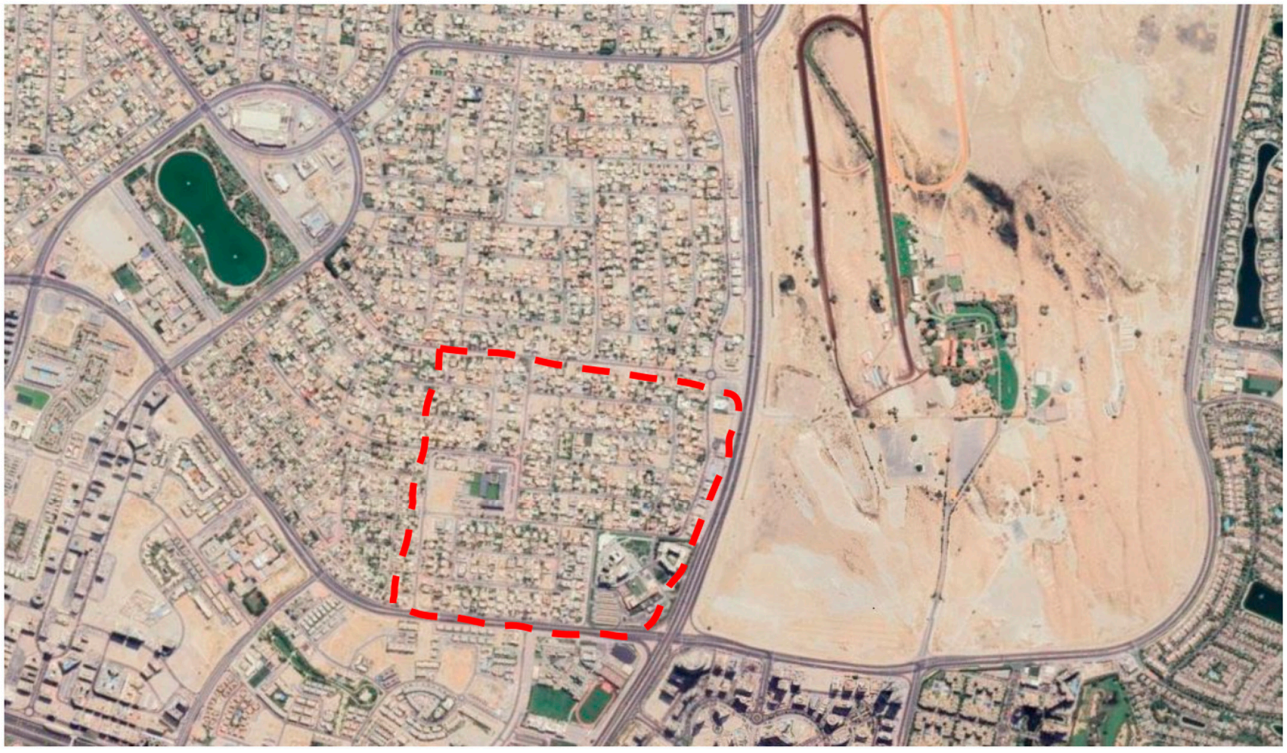


Figure 3. Snapshot of Al Barsha 3 community in Dubai. The red box indicates the perimeter of the study community.

3. Case Study 3 (Al Darari in Sharjah).

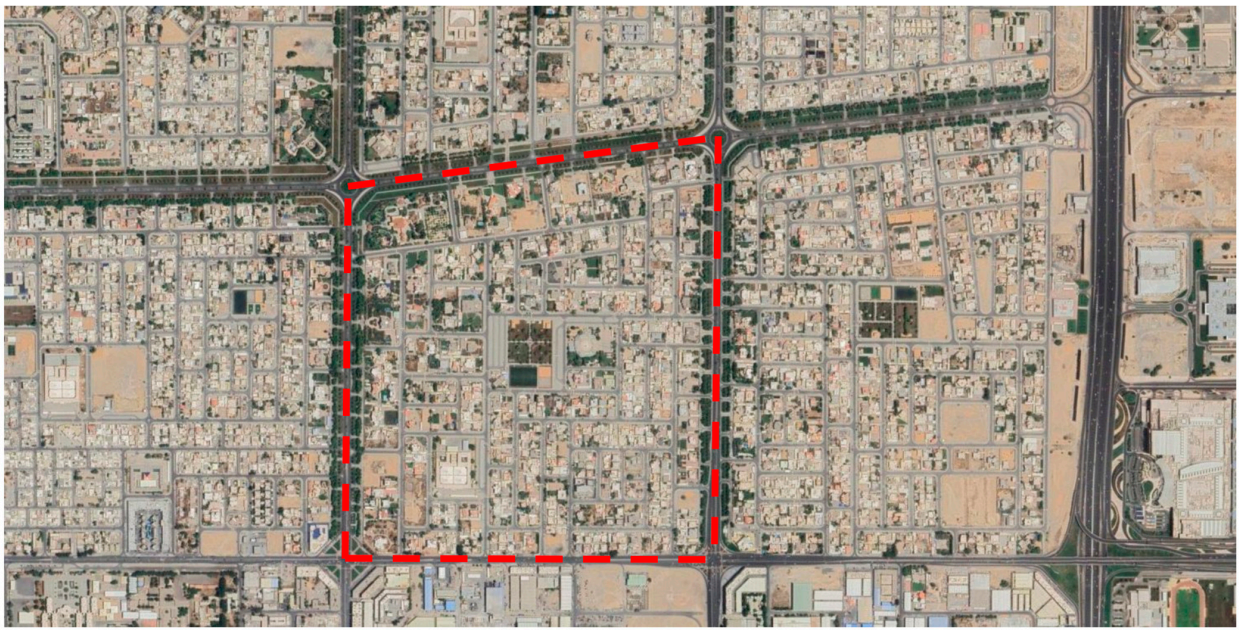


Figure 4. Snapshot of Al Darari community in Sharjah. The red box indicates the perimeter of the study community.

A detailed visual analysis of the liveability indicators in the previous communities can be found in Figures S1–S11, in addition to a comprehensive summary of the indicator evaluation outlined in Table S3. It is worth mentioning that when the researchers conducted the analysis below, subject matter experts' opinions were sought to verify the outcomes of the community analysis. This step was performed to ensure the accuracy, relevance, and appropriateness of the analysis in assessing the liveability indicators. A total of seven experts have participated in this assessment and their details are further explained in File S1 Table S2 and Section 4.4.

4.3. Proposed Design Enhancements

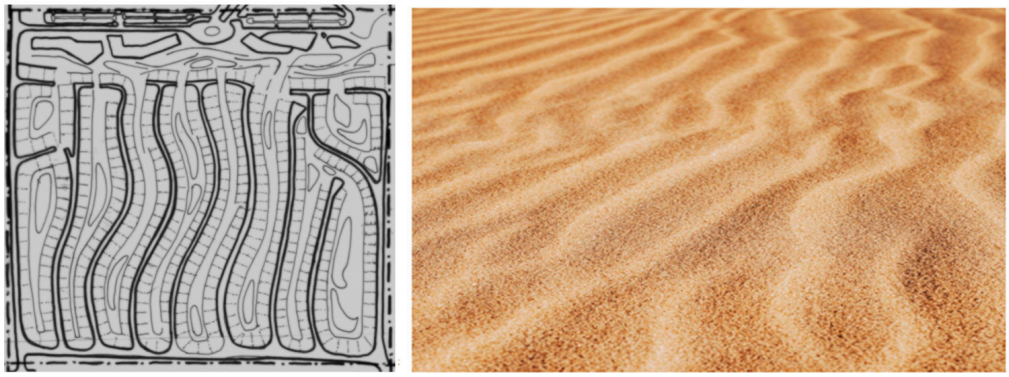
Upon performing the case studies and evaluating the list of liveability indicators against current housing communities in the UAE, a proposed enhanced design was developed to establish a dynamic community that harmoniously integrates contemporary living with a culturally rich, sustainable, and health-oriented environment, all while ensuring affordability. Therefore, the primary objective of this proposed design is to comprehend the existing challenges faced by communities to propose effective solutions.

4.3.1. Master Plan: Concept

The concept entails developing an urban plan that harmonizes with the distinctive characteristics of the desert environment, as shown in Figure 5a. This vision is manifested through the arrangement of the villa plots along a sinuous, multi-bended line, inspired by the undulating patterns found in the desert sand shown in Figure 5b. These elegantly varied shapes traverse the expanse of the land, mirroring the fluidity and grace of desert dunes.

4.3.2. Master Plan: Housing Density and Diversity

The area of plots allocated for villas is 440,000 Sqm, which can accommodate a total number of 345 villas. Each villa would be allocated a 1445 Sqm plot area (Figure 6). The area allocated for the mosque, mixed-use development, healthcare facilities, community center, commercial and retail facilities, and education institutions is 150,000 Sqm. Landscape, relaxation, mental and recreational walking paths, biking lanes, internal roads, and pedestrian routes have a dedicated area of 400,000 Sqm.



(**a**) (**b**)

Figure 5. (**a**) Master plan concept of the proposed design. (**b**) Natural dunes present in the UAE desert.

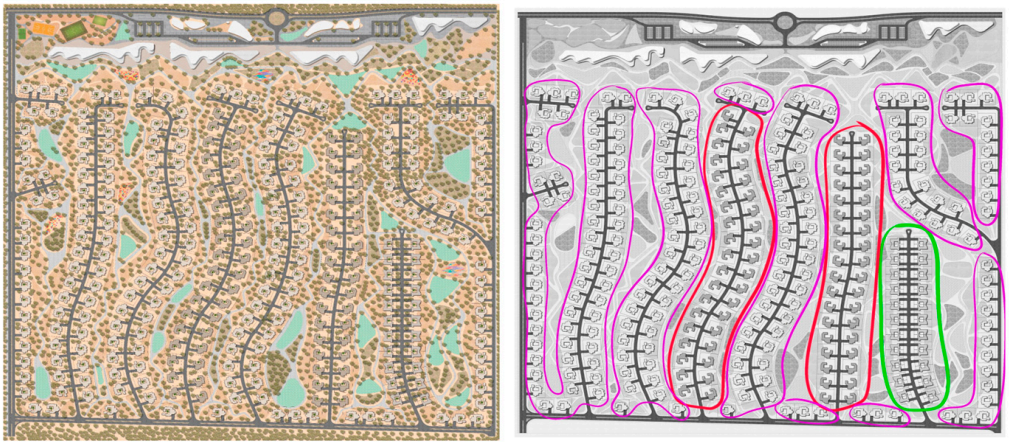


Figure 6. Villa type L: 230 sqm (purple), villa type M: 75 sqm (red), and villa type S: 44 sqm (green).

Additionally, the proposed design incorporates several features to enhance liveability and the quality of life of its residents. For example, within the infrastructure and accessibility dimension, bikeability and biking lane availability are ensured through designated areas for cyclists away from traffic, in addition to pedestrian-friendly infrastructure, sidewalks, crosswalks, public transportation access and coverage, access to high-quality schools and educational institutions, and accessibility within the community through community gardens and restorative spaces available for the elderly and people of determination, inclusive playgrounds, and accessible walkway networks. Moreover, waste collection and waste management are illustrated through a smart waste bin that uses artificial intelligence-based objects to automatically sort recyclables into separate compartments. After sorting, the machine compresses the waste and monitors how full each bin is. Smart waste bins take human error out of the initial sorting process, making material processing faster and easier for recycling facilities; this can lower waste management costs by as much as 80% and drastically improve employee efficiency. Additional features include waste level sensors, AI recycling robots, garbage truck weighing machines, pneumatic waste pipes, solar-powered trash compactors, and E-waste kiosks.

Furthermore, environmental quality and sustainability are demonstrated through green building practices and sustainable design and green space percentages, including open-space frontage, ecological corridors, and pedestrian trails. Moreover, urban planning features powered by renewable resources are provided, for example, smart furniture powered by solar panels, landscape features powered by solar collectors, urban furniture such as lighting features using accumulated daylight solar energy or energy generated by

pedestrian footsteps, misting for gardens, green spaces, and play areas, and organ pipes of varying lengths that produce low tones when the wind blows around and through them.

Additionally, cultural and recreational opportunities are demonstrated through the presence of community centers, gathering spaces, recreational facilities, such as cafes, restaurants, retail stores, and a cultural hub that are all within a 15-min walk, community spaces and design elements that encourage social interaction, integrating public culture and street art, and gathering areas that act as links between landscape and walking paths that encourage social interaction and could easily be accessed from the residential units.

The following figures further detail the enhancements in the proposed design as per the specified liveability dimensions and their related indicators. For example, Figure 7 shows the traffic network, principal road, internal vehicle road, and pedestrian/jogging/biking lanes to showcase the infrastructure and accessibility aspect. Furthermore, Figure 8 highlights the zoning of living activities, including sports activities, social hubs, places of worship, and cultural hubs, amongst other features. Moreover, Figure 9 explains the accessibility to essential amenities while retaining the ecological roads at the site to create a resilient community, complemented by the creation of a living community in Figure 10. Finally, Figures 11–14 provide a visualization of different sections in the community.

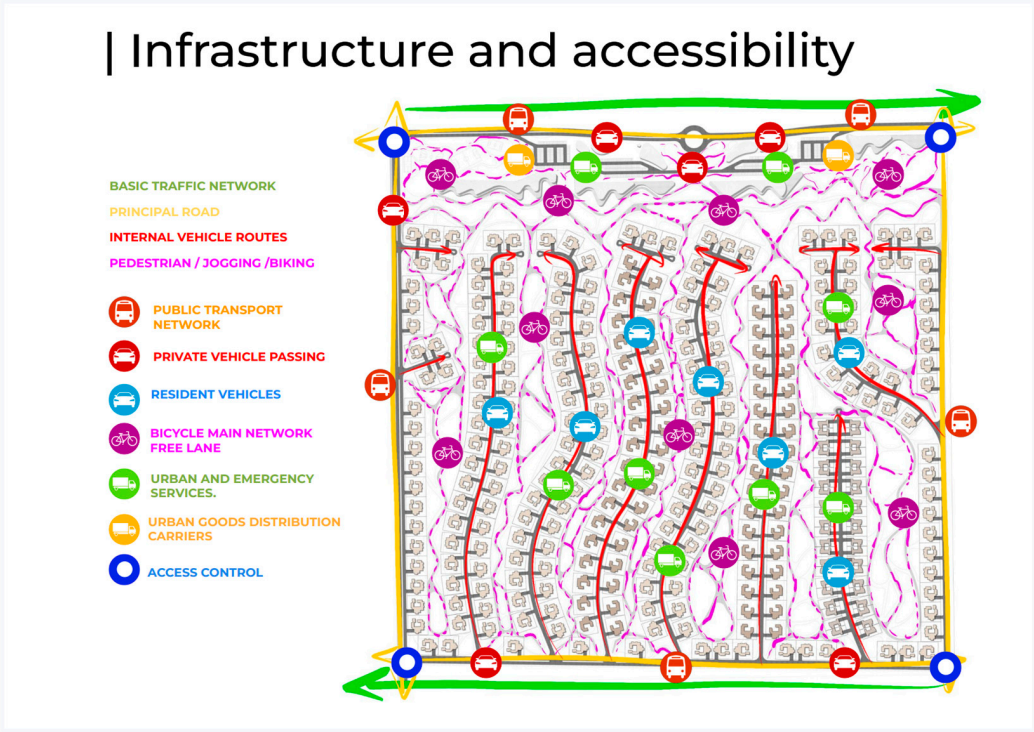


Figure 7. Infrastructure and accessibility.

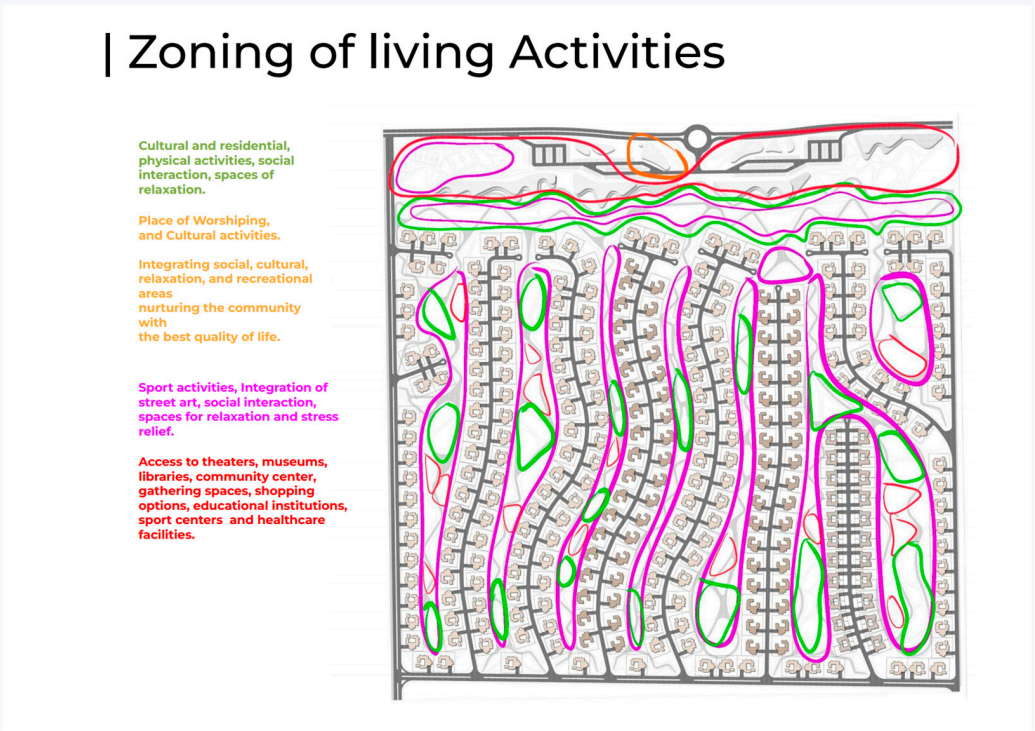


Figure 8. Zoning of living activities.

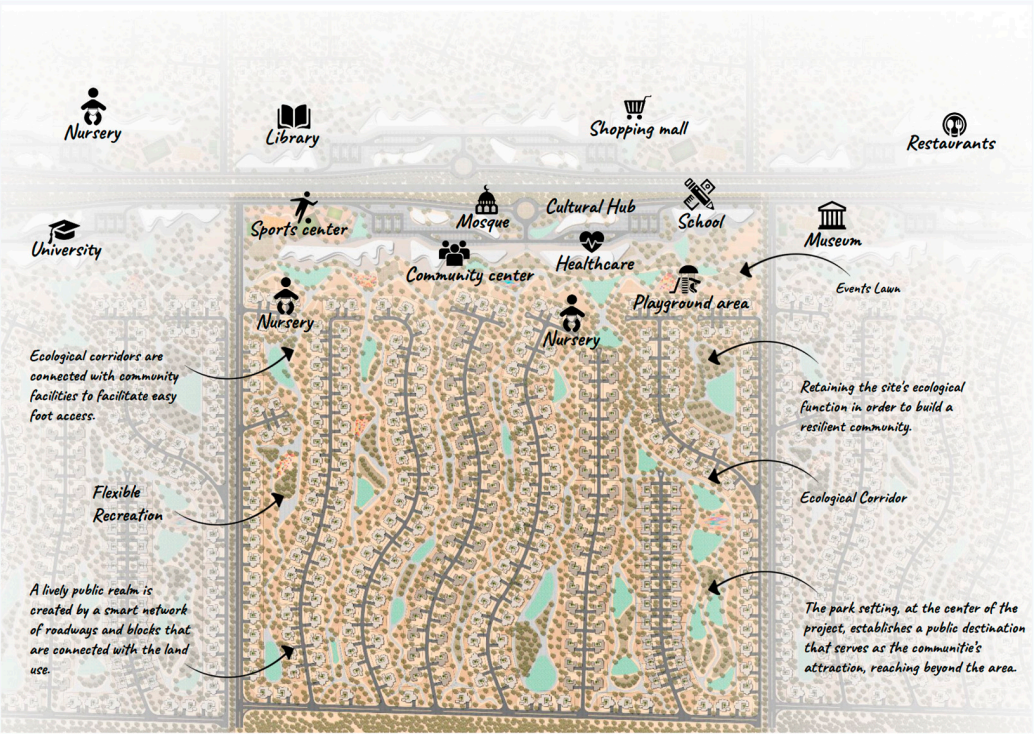


Figure 9. Access to essential amenities.

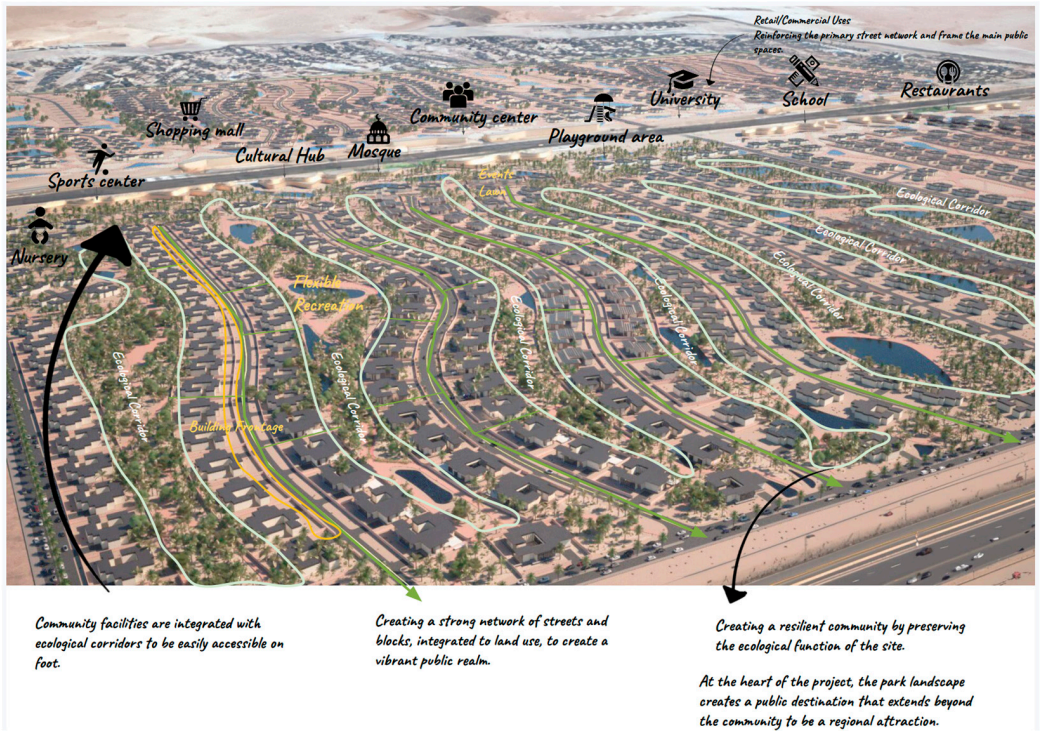


Figure 10. Living communities.

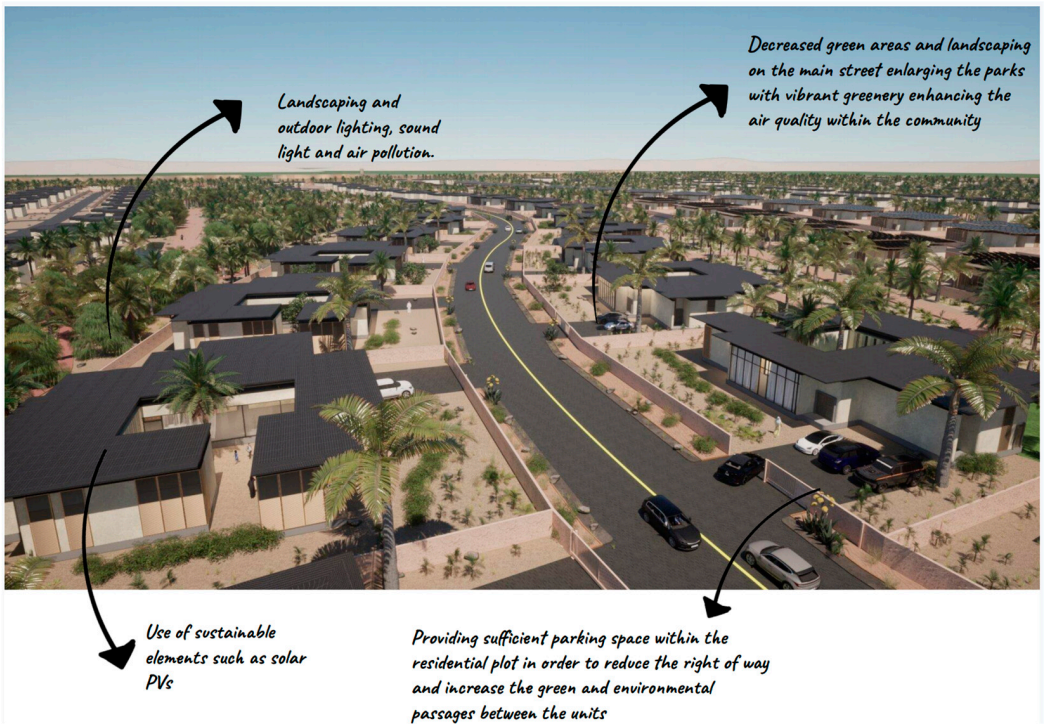


Figure 11. Visual No. 1.

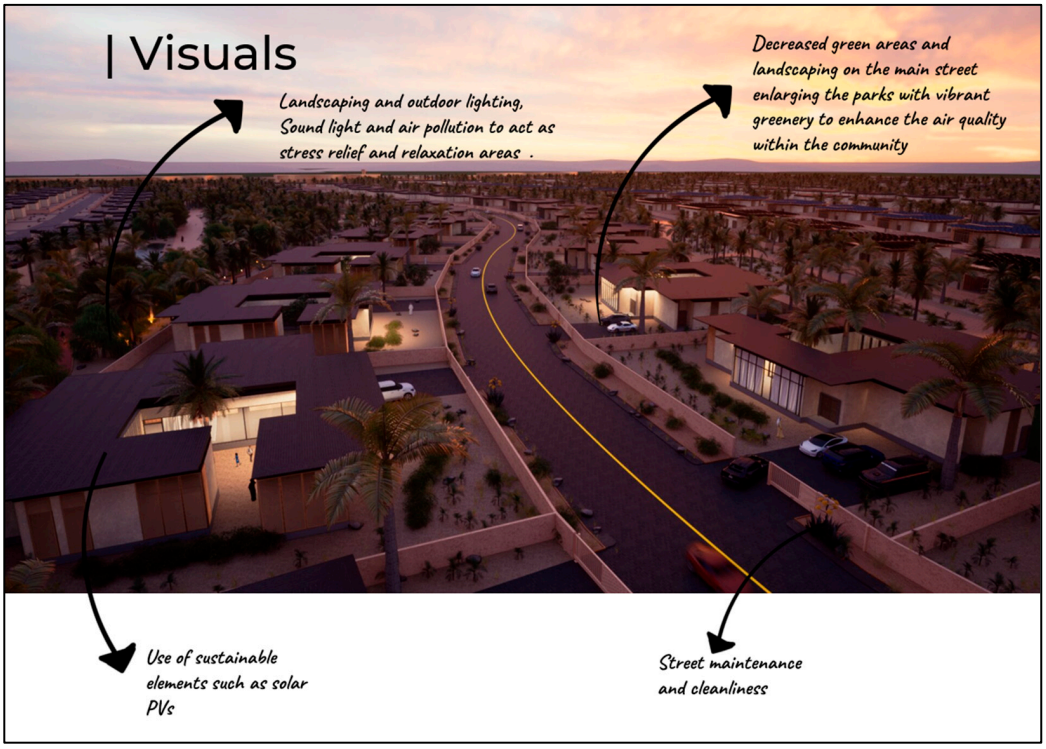


Figure 12. Visual No. 2.

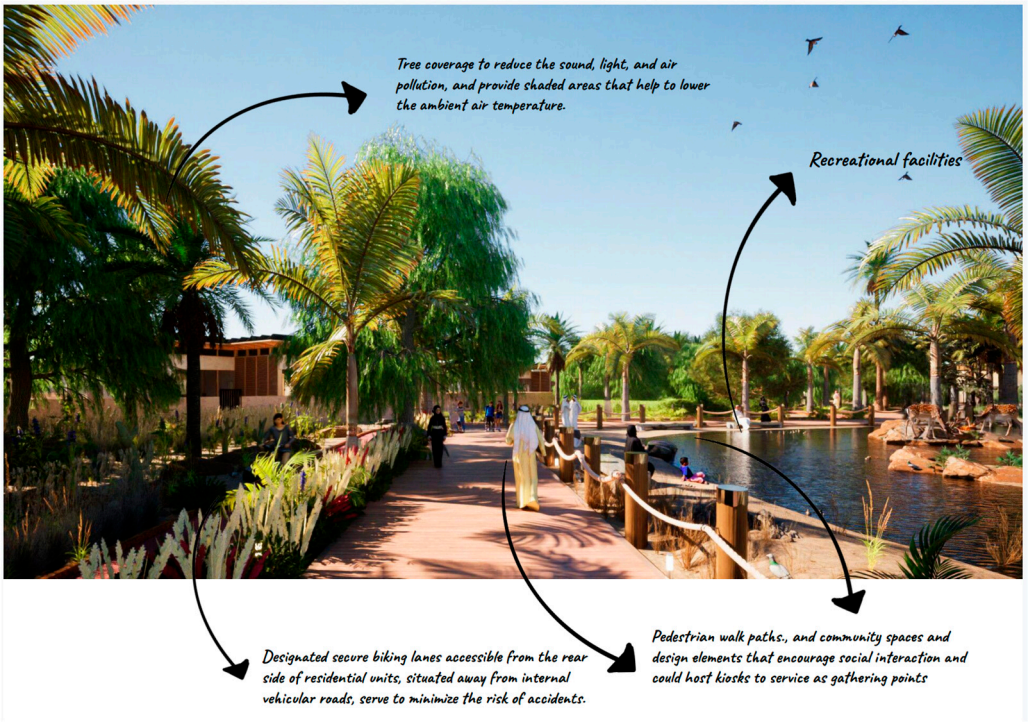


Figure 13. Visual No. 3.

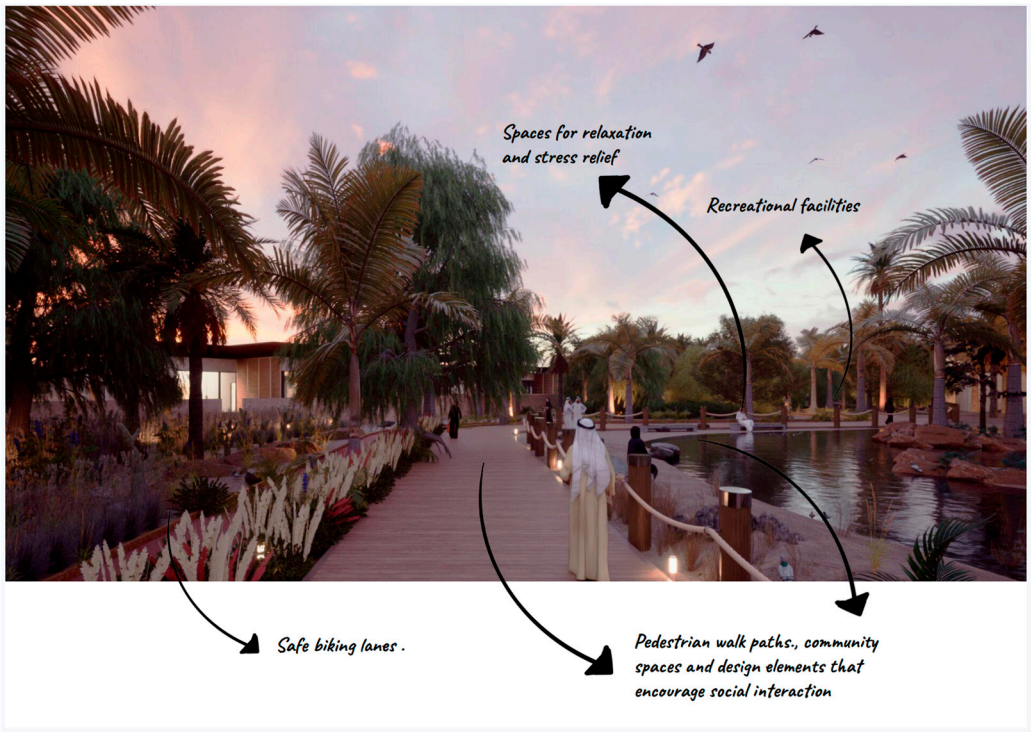


Figure 14. Visual No. 4.

4.3.3. Unit Ideogram: Liveable and Adaptable

The "LA unit" or "liveable and adaptable unit" proposed in this study is designed as a single-level industrial modern house, located in the desert climate. Serving as a residence or family retreat, the house is embedded in the tough, scrubby landscape and uses sustainable strategies and reclaimed materials. It is made from concrete blocks, steel, and glass, and is a home that operates partially off the grid; it was inspired by the tradition of tents around a campfire. This influenced the layout of the house, which comprised three wings connected by the central courtyard as part of the living area. In the living room, a full-height window wall retracts, transforming the outdoor area into the fourth "tent" around the fire. This retractable glass wall helps to create an indoor/outdoor environment, and the roof line extends to provide shade and shelter over the courtyard. In the bedroom, windows have been located in the corner to allow for a floor-to-ceiling picturesque view of the desert. The terrain is planted with dozens of native wildflowers, bushes, and grasses, which further enmesh the home into the natural landscape. The water tank for domestic water usage, the graywater reuse system, outdoor charging stations, and everything else electrical in the house are partially powered by an 8.4-kilowatt photovoltaic array. Despite its size, the LA unit generates approximately 90% less CO_2 than a typical single-family house. Esthetically, it reflects timeless solidity; one could imagine it having stood for decades already—or for centuries into the future. That is no illusion: The walls are made with insulated concrete blocks with an R-value of 30, reinforced with rebar, and filled with concrete grout. The weathered, rusty roof beams are steel—weighing 25 tons total—salvaged from sites all around the emirates. Well-being is addressed through an abundance of restorative spaces, indoor nature access, outdoor landscape views, outdoor nature access, nearby nature access, dwelling access, and dwelling entrance.

Upon applying the liveability indicators to the proposed design, the features were summarized in Table 5, which presents a clear and elaborate analysis of how the proposed design for the housing community features core liveability aspects. These indicators, which have undergone expert consultation, cover different facets such as physical infrastructure, usability, ecology, and community health. The use of these indicators enables the integration

of vital features of residents' liveable needs such as the accessibility, affordability, and environmental sustainability of the designs.

Table 5. LA unit performance against liveability indicators.

Dimension	Indicator	Application
Infrastructure and Accessibility	Accessibility of housing units for people with disabilities	Uses a level plan, so the area is highly adaptable, and dwelling entrances are accessible
	Access to quality of public services (e.g., waste collection, public parks)	Waste bins are incorporated within the boundary wall, making them easily accessible from the street and courtyard side
Housing	Housing affordability (median housing cost relative to income)	Maximized usage of reclaimed building materials (steel, wood, stone), utilitarian architecture, and honest interior design
	Housing quality and maintenance standards	High quality of external and internal spatial organization, climate-withstanding building and finishing materials, and 21st-century sustainable technology solutions incorporated in/out traffic indicators for each house gate
	Sense of privacy in dwelling units	While being part of the community, visual privacy is maintained through a level plan, boundary wall, roof overhang, and window louvres
	Utility costs	Able to operate off the grid for most of the months within a year, graywater reuse, and low-maintenance landscape
	Architectural diversity and design quality	21st-century postulates of architectural timeless solidity, working within the local context of environment, heritage, and future vision of the UAE
	Housing diversity (variety of housing types and sizes)	Core principles of planning are the same for three housing types, varying with different numbers of modules and plot sizes: type L—four bedrooms, type M—three bedrooms, and type SS—two-bedroom house.
	Availability of parking	Plot assigned parking, capacities expendable within the flexible landscape
	Electric charging station/car chargers	Roof PV panels generate electricity for outdoor charging stations (car charging, landscape light, and sound system)
Environmental Quality and Sustainability	Tree canopy cover	Local autochthon date palm trees are positioned to strategically provide shade for the needs outside the house perimeter (car shaders)
	Availability of affordable housing units designed to be sustainable and energy-efficient	The ratio of L, M, and SS units can be adjusted depending on the wider block context
	Renewable energy usage	Water tank for domestic water usage, as well as graywater reuse system, everything else electrical in the house, and outdoor charging stations are partially powered by an 8.4-kilowatt photovoltaic array, reducing usage of the grid by 50%. Despite its size, the LA unit generates approximately 80% less CO_2 than the typical single-family house.
	Recycling and waste management programs/selective waste collection	
	Landscaping	Local autochthon flora and fauna are promoted, as they require very low-key maintenance and the lighting type is attuned to style architecture and uses power generated through solar PV panels.
	Outdoor lighting	
	Green building practices and sustainable design	Obtains UAE Sustainability Building Code, reducing consumption,
	Measurable parameters of the effort to save energy (CO_2 saved, trees saved, etc.)	reducing emissions, and using materials certifiable under the GREEN standards.
	Sound, light, and air pollution mitigation	The boundary wall, roof overhang, and single-level plan control the sound exposure, light pollution is limited through timer-controlled landscape lighting, and
		CO_2 emissions are reduced by largely using clean energy resources, like solar and thermal
	Use of sustainable elements like solar PVs	The walls are made with insulated concrete blocks with an R-value of 30, reinforced with rebar, and filled with concrete grout, the weathered, rusty roof beams are steel—25 tons total—salvaged from sites all around the emirates, and photovoltaic panels are installed for the conversion of thermal energy into electricity, while solar panels convert solar radiation into heat, enabling the two solutions to complement each other
Health and Well-being	Spaces for relaxation and stress relief	To provide serene settings for peaceful reflection and enhance residents' mental well-being
	Community spaces and design elements that encourage social interaction and neighborly relations	The separation between formal and private within outdoor and outdoor areas nourishes traditional gathering activities
	Public safety features integrated into the urban design	Incorporated in/out traffic indicators for each house gate provide high visibility to both pedestrians and drivers
Cultural and Recreational Opportunities	Presence of community centers and gathering spaces	The separation between formal and private within outdoor and outdoor areas nourishes traditional gathering activities
	Integration of street art and public art installations, fostering community identity	The message of the community (sustainability and mindfulness) will translate through core values in function, esthetics principles, and material selection.

Additionally, three different designs for the unit typology were created, as detailed in Figures 15–17. Designing a housing development with a range of housing unit sizes brings multifaceted benefits. Affordability is enhanced through diverse price points, accommodating individuals with varying budget constraints, and offering cost-effective solutions, particularly for first-time buyers and young professionals. Customer choice is emphasized by allowing potential residents to customize their living spaces based on individual needs and preferences, fostering flexibility that attracts a diverse range of residents. The concept of liveability is advanced by accommodating diverse lifestyles and household compositions, promoting community dynamics through a mix of unit sizes, and ensuring adaptability to different life stages without necessitating relocation. Market resilience is achieved through adaptability to changing market trends and increased resilience during economic fluctuations. Additionally, sustainability is promoted as smaller housing units contribute to optimized resource use, aligning with principles of responsible urban development and resource efficiency. Overall, thoughtful consideration of housing unit sizes encompasses economic, social, and environmental dimensions, contributing to the creation of inclusive, adaptable, and sustainable communities.

Furthermore, a variety of design elements were incorporated into the enhanced design to create an attractive environment that fulfills the occupants' needs and enhances their liveability and the overall ecosystem sustainability. Some examples of the incorporated features include the following:

- The desert harvester, which is an artificial water well, operates by utilizing a condensation process to generate and gather water. The system consists of two distinct components: an energy unit that extracts and stores energy from solar PV panels, and a water maker that utilizes this energy to cool a metal plate. When the metal plate reaches a sufficiently low temperature, the moisture in the air condenses on its surface, leading to the formation of droplets that then trickle down.
- The solar roof, which consists of a robust solar roof with three times the strength of standard tiles, ensures constant 24/7 outage protection. The accompanying app facilitates real-time monitoring of energy production, allowing for remote system control, instant alerts, and accessibility from any location. There is also a compact home battery designed to store energy generated by the solar roof, guaranteeing availability day or night, even during outages. The use of larger tiles streamlines the installation process, requiring fewer electrical components and resulting in a more competitive price point. The goal is to achieve an efficient 8-h installation time.
- The graywater reuse system recycles water from showers, baths, and washing machines while also collecting and purifying condensation water from the dryer, heat pump, and air conditioning unit. This innovative approach allows for a significant reduction in tap water consumption and wastewater production, ranging from 25% to 45%, all without compromising comfort. The treated and disinfected reused water is suitable for various purposes, including toilet flushing, washing machines, garden irrigation, and topping up swimming pools. With a volume capacity of 600 liters (160 gallons) and a cleaning capacity of up to 850 liters (225 gallons) per day, depending on user behavior, the system features two valves for directing reusable water to toilets and the washing machine.
- Movable walls are used to establish a partitioning system utilizing structural steel beams spanning the ceiling. The system incorporates attached adapters serving as guides on both the beams and floor channels to ensure the secure guidance of movable walls, each with a depth of 25 mm. The fixed partition block shares identical dimensions with the movable partitions, facilitating the orderly storage of walls on one side when not in use.
- Smart home automation seamlessly integrates the mentioned technological advancements, including devices and services, into a unified system easily controlled through software. This offers several benefits, such as the convenience of managing all home devices from a single platform, flexibility for incorporating new devices and appli-

ances, enhanced home security, remote control of various home functions, increased energy efficiency, improved appliance functionality, and valuable insights for effective home management.

- Insulating concrete forms (ICFs) are advanced construction blocks specifically engineered for superior energy efficiency. With a remarkable 30% increase in EPS (expanded polystyrene) panel thickness, they proudly claim the highest R-value among factory-assembled blocks. The R-value is a measure of the material's thermal resistance, indicating its effectiveness in resisting heat flow. In the case of ICFs, the dual layers of continuous insulation with EPS minimize thermal bridging, forming an airtight envelope that reduces air leakage, optimizing energy efficiency. This innovative combination of high thermal resistance (R-value), air tightness, and thermal mass guarantees a comfortable interior with no drafts. The concrete mass further augments sound absorption, ensuring a quiet and comfortable environment. Beyond its energy-efficient design that diminishes the building's carbon footprint, the durable structure of ICFs provides resilience against natural hazards, ensuring a prolonged service life. Additionally, the incorporation of recycled materials in the wall components contributes to minimizing environmental impact by reducing the demand for raw materials.

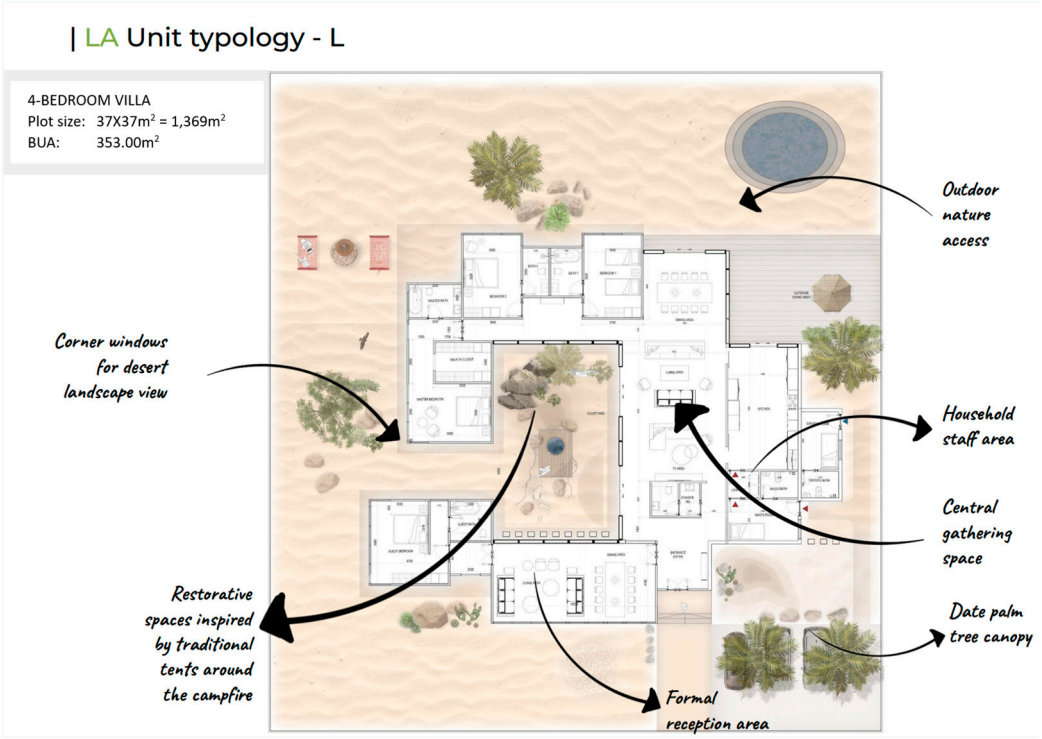


Figure 15. LA unit typology—L (four-bedroom villa).

Additionally, the different housing units per their respective unit sizes of small (SS), medium (M), and large (L) were visualized from the front, back, and courtyard sides in Figures 18–22.

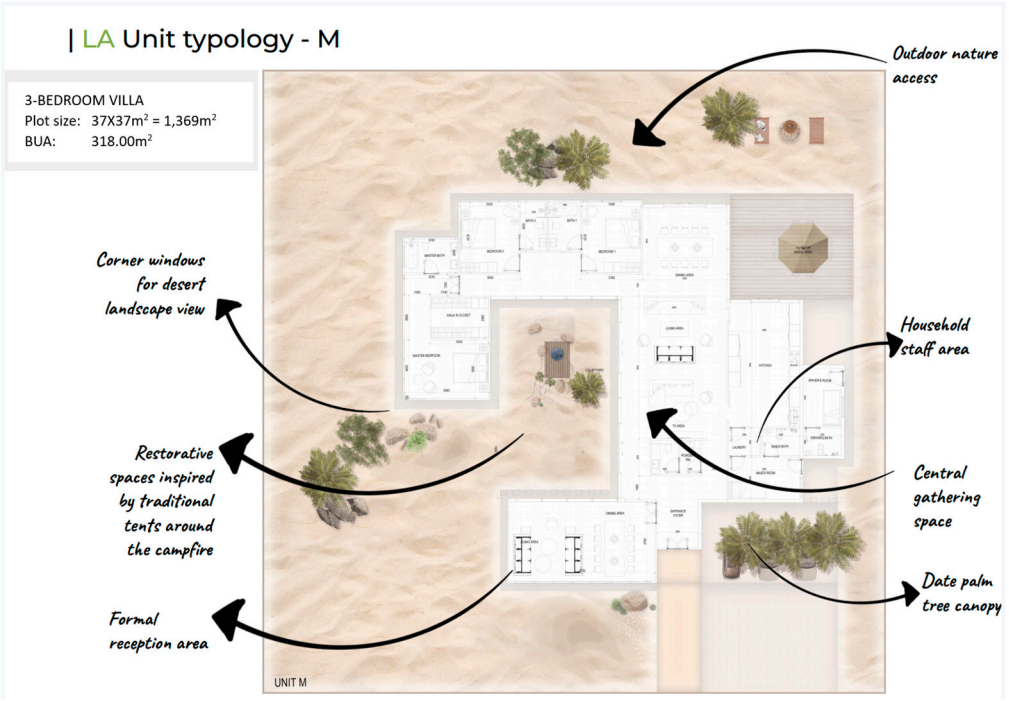


Figure 16. LA unit typology—M (three-bedroom villa).

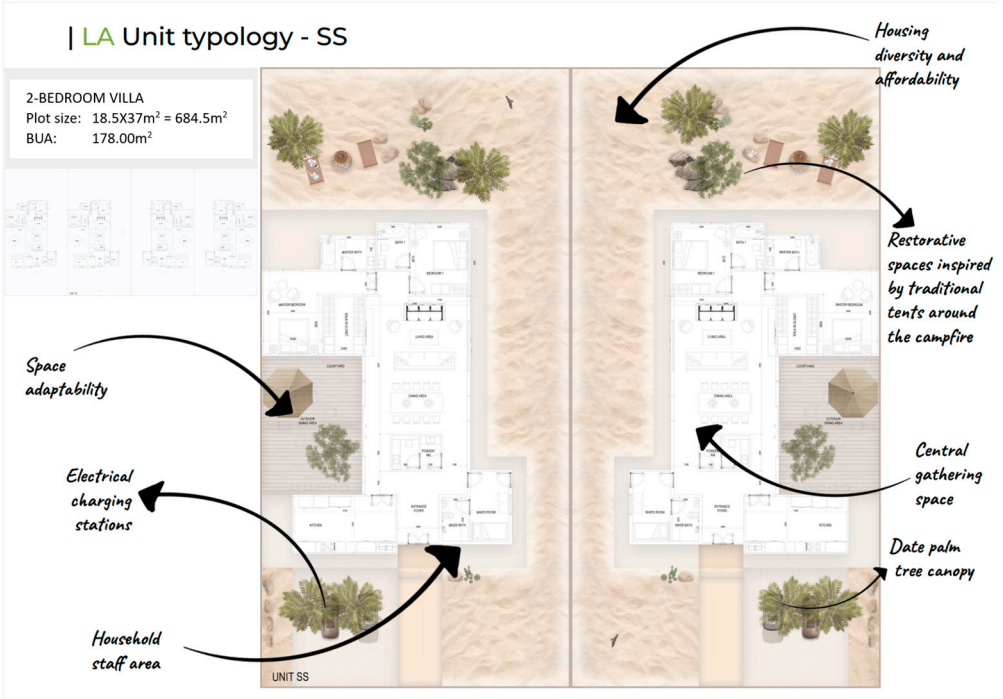


Figure 17. LA unit typology—SS (two-bedroom villa).

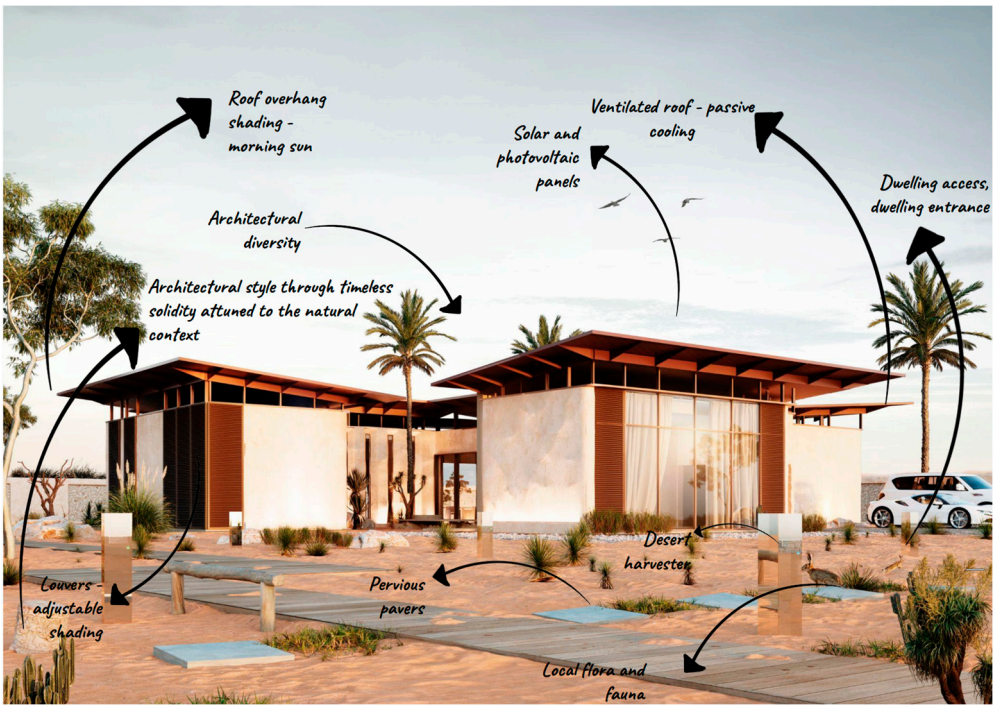


Figure 18. Unit M—front view.

Figure 19. Unit L and M—courtyard.

Figure 20. Unit L—back view.

Figure 21. Unit SS—back view.

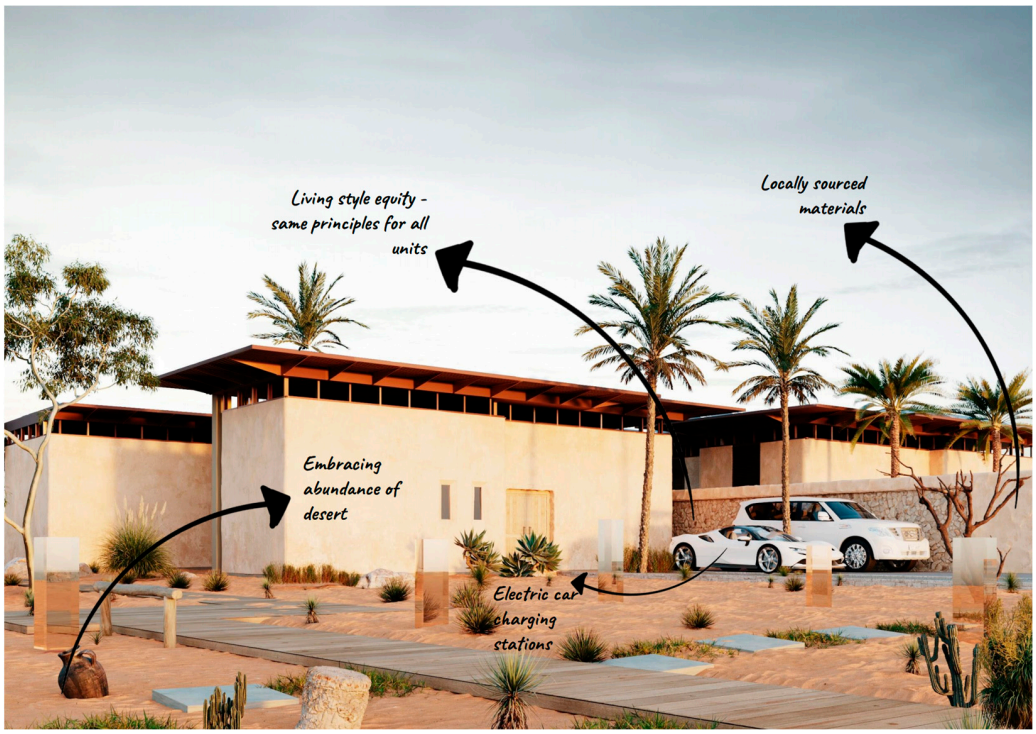


Figure 22. Unit SS—front view.

4.4. Case Study Analysis and Enhanced Design Validation

A total of seven experts were approached to participate in validating the assessment of the communities mentioned in Section 4.2 and the proposed enhanced design. All experts consented to participate in the interview, where they had to complete an electronic form consisting of two sections: the first section included information about their demographics, and the second section listed the dimension of liveability, with their respective indicators. Accordingly, Table S2 in File S1 provides an overview of the demographic details of the interviewees.

The majority of interviewees, making up 71%, belonged to the consultant category, followed by contractors and public sector representatives, each comprising 14% of the total. This distribution aligns with expectations, as consulting firms typically play a central role in the design and conceptualization of residential housing communities, while contractors, real estate entities, and public stakeholders are key implementers and supporting contributors throughout the process. Furthermore, 43% of the participants possessed 5 to 15 years of experience in the construction industry, with another 29% having either 16 to 30 years or over 30 years of experience. This meets the sampling requirement, which mandated a minimum of 5 years of experience in the construction industry for subject matter experts. Such criteria ensured that the insights gathered would be most valuable in assessing the impact of implementing liveability indicators on the enhancement of residential housing community quality of life. In addition, out of the seven experts, 43% had involvement in more than 20 projects related to urban planning, construction, and housing communities, while the remaining 57% of experts had participated in fewer than 10 projects. These data highlight the increasing need for residential housing communities and the high demand for such projects within the construction industry, which in turn draws more companies into the market and presents a potential for benefiting them with innovative designs and concepts to enhance the liveability of residential housing communities.

Based on the number of experts that participated in the analysis, Table 6 shows the indicators that the experts agreed enhanced the proposed design in comparison to the analyzed case studies of current communities. To explain, the top nine indicators mentioned below received 100% agreement among experts, as they believed that these

indicators were enhanced in the proposed design compared to the current status in the case studies discussed previously and in terms of the overall definition of the indicators. Another set of indicators received either an 85.7% or 71.4% level of agreement, which meant that they were partially enhancing liveability in the proposed design but could use further development.

Table 6. Agreement of experts among indicators and their enhancement of liveability in the proposed design.

Dimension	Indicator	Agreement
Infrastructure and Accessibility	Proximity to essential amenities (e.g., grocery stores, healthcare)	100%
Infrastructure and Accessibility	Pedestrian-friendly infrastructure (e.g., sidewalks, crosswalks)	100%
Infrastructure and Accessibility	Accessibility of housing units for people with disabilities	100%
Housing	Housing quality and maintenance standards	100%
Housing	Utility costs	100%
Environmental Quality and Sustainability	Outdoor lighting	100%
Environmental Quality and Sustainability	Measurable parameters of the effort to save energy (CO_2 saved, trees saved, etc.)	100%
		100%
Environmental Quality and Sustainability	Sound, light, and air pollution mitigation	100%
Health and Well-being	Availability of healthy food options to support healthy eating habits	100%
Infrastructure and Accessibility	Public transportation access and coverage	85.7%
Infrastructure and Accessibility	Availability of broadband internet access	85.7%
Infrastructure and Accessibility	Well-maintained streets	85.7%
Infrastructure and Accessibility	Access to quality public services (e.g., waste collection, public parks)	85.7%
Housing	Sense of privacy in dwelling units	85.7%
Environmental Quality and Sustainability	Availability of affordable housing units designed to be sustainable and energy-efficient	85.7%
Environmental Quality and Sustainability	Renewable energy usage	85.7%
Environmental Quality and Sustainability	Recycling and waste management programs/selective waste collection	85.7%
Environmental Quality and Sustainability	Street maintenance/cleanliness	85.7%
Environmental Quality and Sustainability	Green space percentage, indicating the amount of greenery and parks	85.7%
Environmental Quality and Sustainability	Use of sustainable elements like solar PVs	85.7%
Health and Well-being	Access to healthcare facilities and healthcare quality/equity in healthcare availability	85.7%
Health and Well-being	Public safety features integrated into the urban design	85.7%
Cultural and Recreational Opportunities	Access to dining and shopping options	85.7%
Infrastructure and Accessibility	Public transportation access and coverage	85.7%
Infrastructure and Accessibility	Bikeability and biking lane availability	71.4%
Housing	Housing affordability (median housing cost relative to income)	71.4%
Housing	Architectural diversity and design quality	71.4%
Housing	Housing diversity (variety of housing types and sizes)	71.4%
Housing	Availability of parking	71.4%
Housing	Electric charging station/car chargers	71.4%
Environmental Quality and Sustainability	Landscaping	71.4%
Environmental Quality and Sustainability	Green building practices and sustainable design	71.4%
Health and Well-being	Availability of well-maintained parks and recreational areas designed to promote physical activity	71.4%
Health and Well-being	Spaces for relaxation and stress relief	71.4%
Health and Well-being	Community spaces and design elements that encourage social interaction and neighborly relations	71.4%
Cultural and Recreational Opportunities	Access to theaters, museums, and libraries	71.4%
Cultural and Recreational Opportunities	Recreational facilities (e.g., parks, sports centers)	71.4%
Cultural and Recreational Opportunities	The presence of community centers and gathering spaces	71.4%

Table 6. *Cont.*

Dimension	Indicator	Agreement
Cultural and Recreational Opportunities	Places of worship	71.4%
Cultural and Recreational Opportunities	Sport activities	71.4%
Infrastructure and Accessibility	Bikeability and biking lane availability	71.4%
Housing	Housing affordability (median housing cost relative to income)	71.4%
Housing	Architectural diversity and design quality	71.4%
Housing	Housing diversity (variety of housing types and sizes)	71.4%
Infrastructure and Accessibility	Access to high-quality schools and educational institutions	57.1%
Housing	Housing density, indicating the number of housing units per acre	57.1%
Environmental Quality and Sustainability	Tree canopy cover	57.1%
Cultural and Recreational Opportunities	Integration of street art and public art installations, fostering community identity	57.1%
Housing	Availability of mixed-use developments that blend housing with commercial and recreational spaces	42.9%
Health and Well-being	Mental health support services and counseling resources	42.9%

It is worth mentioning that some indicators mentioned above have received a low agreement percentage, ranging between 57.1% and 42.9%. This means that those indicators should be further assessed, as they might not have been incorporated in a way that enhanced the liveability. Also, the subjective opinion of the experts does not necessarily reflect the same opinion as the possible tenants or residents of such communities. Moreover, due to the limitations in time and number of participating experts, it is possible that upon the inclusion of a larger number of experts, the above evaluation might slightly differ. Overall, the purpose of this validation step was to assess the proposed design in terms of enhancing liveability and quality of life within UAE housing communities and to provide an initial idea that could be further developed or expanded into a measure of tenants' perceptions or a ranking of importance for each indicator within each dimension.

4.5. The Link Between Enhancing Liveability, Ecosystem Sustainability, and Climate Change

Enhancing the liveability of housing communities in the UAE's desert climate requires a delicate balance between human needs and the preservation of the natural ecosystem. The UAE, being situated in the Arabian Peninsula, is characterized by a hot arid climate with limited rainfall and extreme temperatures. As the country experiences rapid urbanization, particularly in its desert regions, enhancing the liveability of housing communities while preserving the delicate desert ecosystem becomes a crucial challenge. Therefore, the UAE needs to create resilient and liveable communities that coexist harmoniously with the fragile desert environment through a delicate balance of liveability while preserving the natural ecosystem.

On one hand, enhancing liveability and quality of life in housing communities provides several positive impacts. To elaborate, sustainable design practices, such as water-efficient landscaping and rainwater harvesting systems, can significantly reduce water consumption, alleviating stress on the fragile desert ecosystem. Furthermore, incorporating green spaces, native vegetation, and natural landscaping into housing developments can restore and enhance habitats for wildlife, promoting biodiversity and ecosystem resilience. Additionally, by incorporating environmental education efforts into housing communities, residents can develop a deeper understanding of the desert ecosystem and adopt more environmentally friendly behaviors, contributing to the overall sustainability of the region.

On the other hand, there can be some negative impacts on enhancing the liveability of housing communities through increased urbanization. To explain, urban expansion can fragment and destroy natural habitats, disrupting wildlife movement, reducing biodiversity, and compromising ecosystem integrity. As housing communities grow, the demand for water increases, putting additional strain on already scarce water resources in arid regions. Moreover, urbanization can facilitate the introduction and spread of invasive plant and

animal species, which can disrupt native ecosystems and pose threats to biodiversity. Urbanization can also lead to increased air and water pollution, as well as increased waste generation, which can harm the surrounding natural ecosystem. Finally, as natural areas are replaced by housing developments, ecosystem services such as pollination, water filtration, and climate regulation can be diminished or lost.

To combat the negative impacts of increased urbanization, several strategies can be implemented. For example, encouraging dense, mixed-use development can minimize land use and promote efficient resource utilization. Also, protecting and restoring natural habitats, corridors, and buffer zones around housing communities can help maintain ecosystem connectivity and biodiversity. Furthermore, implementing water-sensitive design principles leads to a reduction in water demand, thereby promoting rainwater harvesting and managing stormwater runoff sustainably. Additionally, incorporating green infrastructure elements such as parks, bioswales, and rain gardens can enhance biodiversity, reduce pollution, and help manage stormwater. Finally, educating residents about the importance of environmental protection can encourage the adoption of sustainable practices in their daily lives. In summary, mitigating the negative impacts of urbanization in a hot arid climate involves a combination of sustainable practices, community engagement, and strategic planning to create housing communities that are both liveable for residents and respectful of the surrounding natural ecosystem.

5. Conclusions

This research outlined a comprehensive study aimed at enhancing the liveability and quality of life in UAE local housing communities. By identifying key parameters, analyzing existing community plans, proposing innovative redesign solutions, and validating these enhancements through expert analysis, this research aimed to contribute to the well-being of residents, support urban development, and provide valuable insights for policymakers, urban planners, and developers in the UAE. To explain, the research findings can guide government authorities in the development of policies and regulations aimed at improving the liveability of local housing communities. Additionally, the redesign proposals and validated enhancements can serve as valuable resources for urban planners and developers seeking to create more liveable housing communities. Moreover, the study's outcomes can directly benefit the residents of local housing communities, leading to improved living conditions and enhanced quality of life. Finally, researchers and scholars in the fields of urban planning, architecture, and social sciences can use the study as a foundation for further research on community liveability.

Overall, the study faced limitations in terms of time and resources available to conduct the research, which impacted the sample size, data collection methods, and the depth and breadth of the analysis. The study's primary concern lied in the uncertainty surrounding the generalizability of its findings. To elaborate, the research centered on housing communities within the United Arab Emirates (UAE), implying that the conclusions drawn may lack universal applicability to regions or countries characterized by distinct cultural, social, and economic contexts. This limitation prompts a critical reflection on the extent to which the study's outcomes can be extrapolated to broader geographical or societal settings. While the findings may offer valuable insights into the dynamics of housing communities in the UAE, it is crucial to acknowledge the inherent constraints associated with the study's localized focus. Consideration of these limitations becomes paramount in an attempt to apply or adapt the research's implications to different global contexts, necessitating a cautious interpretation of the study's generalizability beyond the specific demographic and cultural landscape under investigation.

Accordingly, and to overcome the limitations and uncertainties mentioned earlier, the study has implemented several measures to ensure the validity and reliability of the research. To address the generalizability of the findings, the study used a rigorous methodology that included a comprehensive literature review, data collection from multiple sources, and expert evaluation. The study also took into account cultural values and norms

prevalent in the UAE to ensure that the proposed solutions align with local expectations. While the findings may not be directly applicable to other regions or countries, the study aimed to provide valuable insights and recommendations that can be adapted to other contexts. The study also used robust data collection methods and statistical analysis to ensure the accuracy and reliability of the data. Cross-verification of results through expert evaluation was performed to validate the findings. Finally, the research process was transparent, with results and recommendations shared openly with all stakeholders.

Finally, the broader impact of this research extends beyond local boundaries, with a multifaceted focus on enhancing the liveability and quality of life in housing communities in the United Arab Emirates (UAE) through the integration of liveability and sustainable ecosystem concepts in urban design. The significance of this endeavor is underscored by its responsiveness to a spectrum of concerns at local, regional, and global levels. At the local level, the research directly addresses the pressing need for residential, commercial, and industrial development in the UAE, a nation experiencing rapid growth and transformation. The associated changes in land use have exerted direct impacts on biodiversity, ecosystems, and the sustainable management of natural resources. By embracing liveability and sustainable ecosystem concepts in urban design, the research strives to offer tangible solutions to these challenges, thereby contributing to the creation of more balanced and ecologically responsible urban environments. On a regional scale, the research's relevance extends to other cities in the developing world grappling with similar issues arising from high population growth and rapid economic development. The findings and recommendations emerging from this research possess the potential for adaptation and application in diverse contexts, serving as a valuable resource for addressing shared challenges associated with urbanization, land use, and sustainability. Furthermore, the research resonates with global concerns related to environmental sustainability and climate change. By advocating for liveability and sustainable ecosystem concepts in urban design, this initiative seeks to mitigate adverse ecological impacts and foster the development of environmentally sustainable communities. In this way, the research aligns with broader international efforts aimed at addressing climate change and advancing sustainable development goals. The insights gleaned from this research and the recommendations proposed have the capacity to contribute meaningfully to global endeavors focused on creating more resilient and ecologically sound urban spaces. In essence, the project's value lies in its potential to provide concrete solutions to a spectrum of interconnected issues, ranging from local urban development challenges to broader global imperatives related to environmental stewardship, thereby making a substantial and positive impact on the quality of life across various scales.

6. Limitations and Future Research

At the moment, the framework is only applied to housing communities in the UAE, while the considerations focus solely on the climatic conditions and obstacles related to the further urbanization of the country. However, in follow-up studies, it is possible to analyze how this framework could be adapted for use in other climate zones and stages of urbanization. This research primarily utilizes a qualitative approach, focusing on expert interviews and conducting a case study. Although it provides valuable insights, the inclusion of more rigorous quantitative methods in future investigations would enhance theoretical verification and offer a broader perspective.

One limitation of this study is the relatively restricted number of subject matter experts interviewed. Future research could address this by involving a more diverse range of participants, including stakeholders from different industrial segments or regions, to increase the study's external validity. Additionally, future studies should consider using quantitative methods such as questionnaires or predictive analysis to better assess the impact of liveability factors on the quality of life in housing communities. Incorporating sequential studies could also offer deeper insights into how improvements in liveability affect sustainability and social dimensions over time. While the current framework is

designed for the UAE, it holds potential for application in other regions with different environmental and social challenges in the context of urban and rural development.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/su16229872/s1. Table S1. Demographics of the nine participating experts during the indicators' validation stage. Table S2. Demographics of the nine participating experts during the case study assessment and enhanced design validation stage. Table S3. Analysis of livability indicators in the chosen residential communities within Abu Dhabi, Dubai and Sharjah emirates. Figure S1. Khalifa City Community in Abu Dhabi–Infrastructure and Accessibility Assessment. Figure S2. Khalifa City Community in Abu Dhabi–Cultural and Recreational Opportunities Assessment. Figure S3. Khalifa City Community in Abu Dhabi–Housing Assessment. Figure S4. AlBarsha 3 Community in Dubai–Infrastructure and Accessibility Assessment. Figure S5. AlBarsha 3 Community in Dubai–Cultural and Recreational Opportunities Assessment. Figure S6. AlBarsha 3 Community in Dubai–Housing Assessment. Figure S7. AlBarsha 3 Community in Dubai–Environmental Quality and Sustainability Assessment. Figure S8. AlDarari Community in Sharjah–Infrastructure and Accessibility Assessment. Figure S9. AlDarari Community in Sharjah–Cultural and Recreational Opportunities Assessment. Figure S10. AlDarari Community in Sharjah–Housing Assessment. Figure S11. AlDarari Community in Sharjah–Environmental Quality and Sustainability Assessment

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