

Article

Assessment of the Perception of Sustainability for Occupants of Residential Buildings: A Case Study in the UAE

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Abstract: The residential sector is multi-faceted by nature. Although evidence shows that the UAE is among the countries in the world that take sustainability seriously, there is a lack of information about the perception of sustainability by occupants in the residential sector in the UAE. The aim of this paper is to assess the perception of sustainability of the residential sector in the UAE, which is achieved by following a methodological framework using the relevant literature review and experts' knowledge. An online survey was distributed to the targeted population, followed by a statistical analysis to fulfill the aim of the paper. Results confirm the correlation between social, economic, and environmental aspects of sustainability. Additionally, structural equation modeling reveals that the perception of sustainability is significantly influenced by economic and environmental aspects in the residential sector in the UAE. Comparative analysis shows a statistical difference in the perception of sustainability among gender, educational level, employment status, and monthly income. Finally, a predictive classification model is built to classify the perception of occupants based on their attributes using decision tree algorithms. The outcomes of this study would be beneficial to policy and decision makers, developers, contractors, designers, and facility management entities to enhance overall sustainability in the residential sector.

Keywords: perception; sustainability; residential sector; structural equation modelling; decision tree



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1. Introduction

Sustainable Development (SD) is related to the effect of our current resource use on our planet's natural balance and regenerative power [1]. It is concerned with prudent economic growth and economic development that maintains the resources we need for future sustenance; i.e., how do we live today so that our planet and future generations can thrive [2]? This denotes the need to improve efficiency in resource use and focus on renewables [3].

To achieve a sustainable system, a sustainable mindset needs to be adopted and used to address obstacles and measure progress towards a set of targets or goals. This involves the evolution of a way of thinking as well as a collective lifestyle. Therefore, sustainable systems encompass responsible care, sustainable consumption, and sustainable production [4]. SD has been defined by several studies and entities, however, the initial definition in the United Nation's Brundtland Report, published in 1987, indicates that SD is the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [5]. The definition stresses that all growth should take SD at its core, i.e., the environmental, economic, and social well-being of humanity. Accordingly, the "three-pillar" paradigm was introduced by Elkington [6], which is social, economic, and environmental as demonstrated in Figure 1. To attain a comprehensive and truly sustainable system, all the associated activities should be sustainable in all three dimensions [7–9].

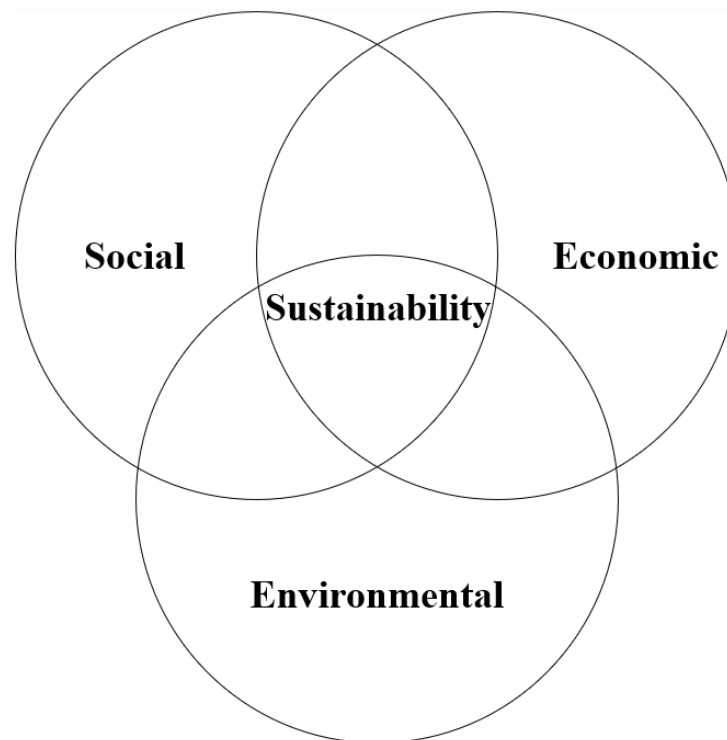


Figure 1. Sustainability Dimensions.

Despite a focus on providing a sustainable built environment in general and residential areas in specific, the sustainability target is not usually set to achieve sustainability pillars in the residential sector. Moreover, amongst all the sectors in the UAE, the residential sector is known to have the highest energy consumption, which implies the highest contribution to the inverse effect on the environment [10–13]. Chartrand [14] noted that awareness must precede attempts at control. Thus, the creation of occupants' awareness is a necessary prerequisite for a change towards responsible behavior and sustainable development [15]. It is suggested that awareness is not an “all or nothing” phenomenon [14]. Hence, occupants' awareness is impacted by to which degree the occupants consciously reflect on their behaviors. Consequently, it is vital to enhance the awareness of this sector regarding sustainability, and this cannot be attained without an initial assessment of the perceptions of sustainability in the housing sector.

Due to the importance of this issue, the following research question will be answered in this study. How do people in residential neighborhoods in the UAE perceive sustainability principles? Thus, this paper aims to measure the perception of sustainability in the UAE residential sector. To achieve this aim, this paper intends to (i) develop an understanding of the progress in sustainability concepts, (ii) identify the main dimensions/indicators based on related literature studies, green rating assessment tools, and experts in the field, (iii) collect data from occupants of residential buildings in the UAE based on the adopted sustainability indicators, and (iv) test the proposed hypotheses and draw conclusions. The hypotheses are for testing the correlation among the three pillars of sustainability, as well as the positive impact of each pillar on the perception of sustainability by occupants in the residential sector in the UAE.

The review of the literature is drawn from several relevant sources. First, it investigates green building rating systems, then it focuses on awareness and perceptions of SD in the UAE. Subsequently, it highlights the link between awareness and behavior, and finally, it investigates the related sustainability indicators in the context of the UAE residential sector. The following subsections elaborate on each component of the literature review.

1.1. Green Building Rating Systems

The impact of buildings on the environment has become increasingly important in recent decades as the construction sector contributes significantly to carbon emissions, global warming, and environmental degradation due to its high consumption of natural resources and high energy use [16]. Worldwide, the residential sector is one of the major consumers of energy—mainly electricity and natural gas [17]. It consumes natural resources and impacts the environment. However, sustainability is not only concerned with environmental issues as it involves an interaction between a triple bottom line framework comprised of social, economic, and environmental factors. Therefore, the importance of residential buildings has been increased, which raises attention to the importance of enhancing their sustainability.

Government agencies and organizations have adopted green building rating systems to minimize the consumption of natural resources and control pollution. In order to evaluate the impact of the building sector on the environment, various sustainability assessment methods (assessment systems) have been implemented, such as Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environmental Assessment Methods (BREEAM), Sustainable Building Tool (SBTool), DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen-German Sustainable Building Council), SBTool (Sustainable Building Tool), and the Comprehensive Assessment System for Built Environment Efficiency (CASBEE) [18]. In recent decades, the need arose to develop specific tools for different countries and different types of buildings, such as assessment tools for residential buildings, hospitals, and schools.

1.2. Sustainable Development in the UAE

The UAE has been one of the pioneering countries in considering sustainability as a serious issue that concerns the future of the country. Several landmark projects are supporting the movement to a more sustainable and livable future. This is achieved by focusing on the Sustainable Development Goals (SDGs), which consist of 17 interconnected goals to attain a better and more sustainable future for all [19]. Consequently, the UAE has put in place several initiatives to drive the country to a more resilient and sustainable future by enabling ways to health care, sufficient and affordable food, economic growth, quality education, a healthy environment, and efficient use of resources [20]. To illustrate, the UAE energy strategy targets increasing the share of clean energy resources by 50%, increasing consumption efficiency by 40%, and reducing its carbon footprint by 70% by 2050 through the implementation of several initiatives across the country [21].

The main initiatives toward SD in the UAE include: (i) ESTIDAMA Pearl Rating System (PRS), which was established in 2009 by Abu Dhabi government to be one of the leading sustainability frameworks in the Middle East, where all the developments are required to meet at least the minimum number of pearls based on this sustainability rating system [22], (ii) Al Sa'fat initiative, which replaced Dubai Green Building Regulations and Specifications in 2020; it includes a comprehensive set of requirements for all new developments to secure a more sustainable environment in the future [23], (iii) Masdar City—Abu Dhabi, which was initiated in 2006 to help implement sustainability practices in an urban development [24], (iv) Sustainable City—Dubai, which was established in 2015 to focus on the three dimensions of sustainability by implementing sustainability practices that improve the occupants' lifestyle [25], (v) Sharjah Sustainable City, which was established in 2021 as a continuation of the sustainability success of the Sustainable City—Dubai [26], (vi) EXPO2020, which is designed, built, and operated in a sustainable manner that makes it one of the most energy efficient development [27], (vii) Mohammad Bin Rashid Al Maktoum Solar Park, which is anticipated to reduce the carbon emission in the UAE by 6.5 million tons per year [28], and other governmental initiatives that support sustainable development goals (SDGs), such as Al Jalila foundation, Dubai cares, food bank, Dubai cares water, sanitation, and hygiene, international humanitarian city, Mohamed Bin Rashid Al Maktoum Global Initiative, Noor Dubai foundation, sustainable schools, UAE water aid initiatives, and the Zayed Bin Sultan Al Nahyan charitable and humanitarian

foundation [29]. As per the SD report of 2021, the UAE has an overall score of 70.17% in achieving the 17 SDGs [30]. In addition, according to Asif [31], the UAE is leading the sustainability trends among the GCC countries, also having the highest share of green buildings in the whole Middle East and North Africa (MENA) region.

According to [32], residential buildings are among the essential community conditions that describe the healthy quality of life and well-being of people. In addition, residential buildings consume about 40% of the world's electricity and account for up to one-third of global greenhouse gas emissions in developed and emerging economies [33]. In the UAE, the residential sector has seen a remarkable increase in electricity consumption—the consumption has increased from 6580 GWh to 12,795 GWh from 2006 to 2017 [34]. Therefore, it is apparent that special attention should be given to this sector to enhance the overall sustainability of the three sustainability pillars.

1.3. The Link between Awareness and Behavior

Awareness of environmental problems has grown in the second half of the twentieth century [35]. In addition to environmental problems, human society has also undergone dynamic changes due to advances in communication, technology, and globalization. The social structure and economic conditions of the current world have led to an increase in global inequality and polarization in society. Understanding the integration of environmental, social, and economic aspects of human and natural systems has become crucial [36]. Consequently, people need to understand how their activities impact the environment, including social and economic aspects, and what they can do to minimize the adverse impacts [37,38]. This position claims that increasing people's awareness of sustainability within their communities can encourage them to implement sustainability principles and practices in their day-to-day activities. Several related terms are often used interchangeably with sustainability awareness; these include green awareness, environmental awareness, environmental knowledge, carbon literacy, energy literacy, environmental literacy, and ecological literacy [39].

A review of current literature reveals that considerable attention is devoted to sustainability in general and environmental sustainability in particular, which some authors describe as having an enviro-centric view [40–42]. Vasconcelos [43] argues that “for too many people the word environment still signals ‘green’ and fails to convey its social, economic, political, and cultural components”. Research into awareness, perceptions, and behavior in terms of sustainability in the residential sector is limited, but there is more evidence that behavior is built on perceptions and attitudes when addressing energy saving and recycling, energy efficiency, and climate change [44–46]. Environmental behavior remains the most widely and systematically studied subject within the existing socio-psychological literature [47–49].

Several studies have been conducted to develop strategies aimed at enhancing people's awareness, perceptions, cognitive abilities, motivations, and behaviors to promote household sustainable practices. For instance, a study conducted by [50] in 2008 showed that there is a problem with people's perceptions and behaviors when using sustainable energy and water technologies. Later, in 2010, a need for further research was identified by [51] in the area of users' perceptions, behaviors, attitudes, and expectations for sustainable measures. Previous studies have shown that building occupants play a critical role in the built environment, as 50% of energy consumption in residential buildings depends on the behavior of buildings occupants [52].

Moreover, an investigation conducted by [53] suggested that energy-efficiency behaviors account for 51%, 37%, and 11% of the variance in heat, electricity, and water consumption, respectively, between dwellings. Abrahamse and Steg in [54] argued that in order to change household energy consumption behavior, it is important to understand the impact of sociodemographic and psychological factors on household attitudes and perceptions toward green building development, particularly to identify barriers and opportunities to achieving sustainable homes from the household perspective. Later in 2013, several

studies were conducted in different countries to address the contribution of occupants of residential buildings to actual energy consumption from different perspectives [55,56]. In addition, a framework to improve the sustainability of residential buildings was proposed by [57], which investigated the motivation and behavior of residential building occupants in terms of energy savings and its impact on greenhouse gas emissions. Canale et al. [58] contend that the physical properties of the buildings alone are not enough to reduce their energy consumption and that occupants' behavior is an influential factor in the real energy consumption of a building.

In addition, several studies have assessed the impact of environmental awareness on pro-environmental behavior [59]. For instance, Sekhokoane et al. [60] claimed that individuals with high environmental awareness are more likely to behave in an environmentally sustainable manner. Similarly, Yilmaz et al. [61] found that lack of awareness could lead to insignificant and minimal changes in individual behavior, and, consequently, dependence on government actions. Nevertheless, awareness does not necessarily result in environmental behavior [62]. Hadlock and Beckwith [63] indicated that individuals do not willingly behave sustainably and in favor of the environment unless they experience opposing impacts of environmental problems. Accordingly, there is a lack of consensus in the literature on the environmental awareness–behavior relationship [64]. Most of these studies have concentrated only on certain and selected aspects of environmental awareness. This study argues that this approach to identifying awareness and perception has limitations as it only captures a part of this whole construct. It attempts to create a comprehensive model, which provides a holistic means of assessing the perception of sustainability taking into consideration its three pillars (economic, social, and environmental).

Despite the complex and multi-dimensional nature of sustainability in terms of balancing the three pillars, environmental, economic, and social, prior research often focused on a single dimension—the environment. Although a good deal of research has been published in the area of sustainability, there are very limited studies that have addressed sustainability awareness and application as a whole [38]. Hence, investigating stakeholders' awareness and behaviors in the residential sector is essential to understand the dynamic interactions and promote coordination among them [65]. The significance of such research can be a base for improving the decision-making process and promoting sustainability in the built environment [66].

Although studying occupants' perceptions and behaviors toward more efficient resource use can have an impact on energy conservation and the reduction of emissions, a clear understanding of occupants' perception of the big picture of SD including the three dimensions (economic, environmental, social) helps policymakers, designers, and building professionals not only identify gaps in current policies and develop potential new technologies, but also understand the attitudes, knowledge, preferences, and behaviors of building occupants toward sustainable measures and improve their behaviors through educational programs.

1.4. Sustainability Indicators

Sustainability perceptions by residential occupants are assessed based on the extracted indicators from the relevant literature, where the final selection of the indicators is verified by experts in the field to assure their compliance with the prevailing standards and regulations within the UAE. Several studies have discussed the sustainability of residential buildings; however, it is an evolutionary process that needs to be continually enhanced, considering any change that impacts the social, environmental, or economic pillars of sustainability.

According to [67], the first category is health and safety, and it involves the prevention of virus propagation using new smart, innovative, and touchless technologies [67–70], self-cleaning spaces [71], proper selection of indoor materials [70,72], allowing natural daylight (as sunlight enables a healthy environment and prevents the viability of viruses) [73,74], and the adjustability of indoor temperature and humidity; these are all influential factors

in virus propagation, yet they are subjective to the perception of occupants [75–77]. The second category is mental health for occupants, which includes the availability of greenery and gardens such as indoor gardens, green views, and green balconies, which enhance relaxation and reduce the risk of stress-related diseases [78,79], availability of outdoor spaces in the building (balconies) as they improve the mental health of occupants [80,81], access to common building spaces with sufficient safety and social distance, and household-level activity/sports spaces to boost immunity and reduce stress.

The third category is air quality, and it includes the efficiency of air filtration systems to monitor and control indoor air pollution and develop a moderate fresh air circulation [67,82]. Ref. [83] highlighted that people's perceptions of the indoor environment depend on an interaction between the physical properties of the room (temperature) and the psychological associations with the 'green' certification. The fourth category is water quality and availability, and it includes safety measures for drinking water and/or tap water from contamination [67,84]. Finally, the fifth category in this group is related to wastewater management and it includes specific measures to limit virus propagation at a household level to avoid transmission of viruses through wastewater [85,86].

Moreover, the environmental resources consumption category includes three aspects [67], where the first aspect is related to energy use, promotion of sustainable and alternative energy sources to improve the environmental effect, and the use of energy-efficient appliances to resolve the increase in energy consumption. The second aspect is for waste management [87], and the last is related to water consumption including the access to alternative water sources as well as the use of water-efficient appliances and fixtures.

In addition, the last category of sustainability as discussed by [67] is comfort, which has two aspects: personal comfort and local services. Personal comfort is related to a specific emphasis on household-level ICT infrastructure access to enable studying, working, food delivery, and medical consultation [88,89], levels of indoor space adjustability [78], and acoustic comfort [90]. On the other hand, local services include the availability of self-dependent services in residential complexes, especially for medicine and food [91], and urban/community farming to reduce the paths for food supply and enhance mental health [92]. Based on the aforementioned sustainability indicators, expert groups from academia, industry, and medicine were surveyed in 17 countries [93], and the results showed that health and safety have the highest importance, with more attention paid to the prevention of virus propagation, mental health, and air quality. Additionally, the experts agreed that touchless technologies, self-cleaning spaces, and smart technologies contribute to avoiding the spread of viruses.

According to global definitions of social sustainability, the needs of social groups should be addressed to improve overall satisfaction [94]. In terms of occupants' needs in housing, the social aspect of a well-known sustainability assessment scheme only considered indoor environmental quality in most of the studies in the literature. However, social sustainability includes various issues from safety to other physiological and psychological needs of stakeholders [95]. Based on this, many researchers exploited social indicators for the sustainability evaluation of buildings based on the context of their countries. For example, Ahmad and Theheem [96] developed a social sustainability assessment framework for residential buildings in Pakistan to address the lack of social aspects in the assessment framework of this country. Likewise, Ullah et al. [97] developed a framework focusing relatively more on social issues for assessing the sustainability of residential buildings in Pakistan.

Similarly, a recent study conducted by Fatourehch et al. [94] addressed sustainability issues in the assessment framework of residential buildings in Iran. This study considered more detailed indicators in terms of social aspects of sustainability issues regarding Iranian residential buildings. It investigated the most common social aspects, which were identified by prior literature for the assessment of residential buildings worldwide. In addition, Maleki et al. [98] formulated a sustainability assessment model highlighting the social sustainability aspects of residential high-rise buildings (RHRB). The authors argued that

emphasizing the social indicators is important, as they are effective for assessing the human relationship with the physical environment (housing).

Another study conducted by Karji et al. [99] sought to rectify the evaluative inequity between the social bottom lines and the economic and environmental bottom lines of sustainability within the existing sustainability rating systems for buildings (LEED, BREAM, CASBEE, etc.). The indicators were tested in one of Iran's largest mass housing projects. In previous research, some researchers have reviewed existing literature regarding sustainability assessment for buildings. For example, Sierra et al. [100] conducted a comprehensive review of various Green Building Rating Systems (GBRS) adopted by the current sustainable construction community. The authors note that despite the vast research regarding GBRS, little has been done to examine the stakeholders' perceptions of GBRS.

In addition, [101] has built a multi-criteria framework to assess the sustainability of buildings in Kazakhstan; the sustainability categories and indicators were extracted from four assessment tools (LEED, BREEAM, CASBEE, and SBTool) as well as the related literature, then experts were interviewed to specify the indicators that are applicable in Kazakhstan, where 35 indicators were validated for the analysis. Alyami et al. [102] designed a measurement framework to evaluate the principles of sustainable construction for residential buildings in Saudi Arabia by analyzing the leading international sustainable assessment schemes: BREEAM, LEED, SBTool, and CASBEE. The authors concluded that international schemes are inapplicable for the Saudi context, and there is a need to develop further categories and criteria for the assessment of the built environment in Saudi Arabia.

Interestingly, another study has been conducted in Kazakhstan to assess sustainability in residential buildings and how far is it from the green building indicators [103]; the study was based on a survey of occupants that covers different sustainability categories. The result of this study indicated that old buildings tend to have a poor sustainability level based on the responses of their occupants, while new buildings have an increasing interest in sustainability, especially when it is linked to economic aspects. Kamali and Hewage [104] conducted qualitative and systematic research for sustainable building rating systems and journal/conference articles to develop a list of sustainability criteria related to each sustainability pillar (TBL).

In addition, six case studies were conducted in Brno and Vienna [105] to study how open spaces between residential buildings affect sustainability. The results support the importance of green open spaces in enhancing the SD for the residential sector; however, the indicators were obtained from a comprehensive literature review. Winston [106] outlined an analytical framework for assessing sustainable housing and regeneration in Dublin, Ireland. This framework included characteristics that are associated with each of the key aspects of housing, which were derived from literature on sustainability. Another customized sustainability assessment system for multi-apartment buildings in Slovenia was proposed by [107]; although various aspects were included in the system, such as functionality, safety, and security aspects, the economic aspect was not considered.

Moreover, a case study was performed in Portugal to assess the sustainability of new, existing, and renovated residential buildings [108]. The indicators were obtained from the SBTool assessment system by customizing the set of indicators that are related to the context of the study, and they covered the three dimensions of sustainability; the proposed methodology supports the direction towards sustainability by identifying the objectives for the contractors working in residential sectors. Another study was conducted in Malaysia to identify and rank sustainability indicators for assessing green buildings [109]. This was accomplished through employing appropriate GBRSs and their associated sustainability indicators to evaluate and confirm the level of greenness and sustainability of buildings in the manufacturing sector.

Al-Jebouri et al. [110] developed a framework for sustainable building construction in Oman by proposing an assessment system for the construction industry. The indicators of the proposed rating system for Oman were derived by reviewing the literature on SD and buildings as well as analyzing international and regional sustainable building-rating

systems, such as LEED, BREEAM, and UAE Estidama. Moreover, Karaca et al. [76] argue that existing methods in the literature mostly suggest indicator scores in construction sustainability assessments using highly technical data and require a high level of engineering expertise. Therefore, the authors developed a detailed method called A Rapid Sustainability Assessment Method (RSAM) that uses residents' opinions-based sustainability in Kazakhstan.

A set of ratio-based indicators and rating functions for building rating systems in a global context was developed by [111,112], where the building sustainability rating system was proposed with two main features, namely, the use of quantifiable indicators instead of subjective ratings for aspects, and the use of continuous functions for indicator ratings because such functions allow better comparisons between buildings than step functions. In addition, a contextual assessment approach for residential buildings in Hongkong was proposed by [113]. The proposed approach aimed to assess and improve the integrated sustainability of public rental housing to improve the livelihoods of middle-and low-income families.

Given that the majority of the proposed assessment tools and methods were either complex or focused only on single issues, this encouraged researchers to develop simplified methods for assessing building sustainability. Markelj in [114], for example, developed a simple method for assessing the sustainability of Slovenian buildings in the early design phase and included economic and safety aspects in addition to the basic categories. In 2016, Raut [115] proposed a system for assessing the sustainability of residential buildings in Mumbai. The proposed methodology was used in the selection of sustainable residential buildings, using both relative benchmarking and absolute benchmarking, which provides a tangible means of evaluating residential buildings.

A study performed by Janjua et al. [116] proposed a holistic life cycle sustainability assessment (LCSA) framework based on the TBL indicators to address the sustainability performance of residential buildings, specifically for assessing Australian buildings. The TBL indicator selection was carried out systematically based on a literature review. After that, the stakeholders directly or indirectly involved in the building sector were given a platform to provide their opinions and become a part of the selection process of indicators. Another framework was developed by Kamili et al. [117] for the sustainability assessment of modular buildings. The authors conducted a comprehensive literature review including reviewing different rating systems such as LEED, Green Globes, and LBC, as well as journal/conference articles.

In addition, an assessment scale was proposed to evaluate sustainability from the perspectives of residents—as the main stakeholders—in Thailand. The authors extracted their indicators using theoretical bases from a literature review of related concepts, such as sustainable cities, urban sustainability, sustainable urban forms, and eco-cities [118]. Furthermore, it was noted that construction and buildings' operation are, from the perspective of SD, unsustainable energy processes. Therefore, the authors developed an overall sustainability index based on the TBL indicators. They note that defining and determining the economic, social, and environmental indicators was developed based on the energy consumption of residential buildings in Belgrade city in Serbia [119]. In addition, Amasuomo et al. [120] established an assessment tool for residential buildings in Nigeria based on international rating tools to adapt it to the Nigerian requirements.

In the context of UAE, a few papers have looked at sustainability assessment and indicators in the residential sector, although there is a good deal of research in this area. For instance, Ref. [121] assessed the sustainability of three types of building (heritage, ordinary modern, and sustainable modern buildings) using the Analytical Hierarchy Process (AHP) based on conducting a survey that targeted experts only. The purpose was to integrate the sustainable principles and enhance the overall sustainability of these buildings. Moreover, the results showed that sustainable modern buildings are the most preferred alternative, followed by heritage buildings and ordinary modern buildings. Furthermore, amongst the sustainability dimensions, economic and environmental have the highest priority. In a study

conducted by Baird [122], a worldwide set of commercial and institutional buildings, with well-recognized sustainability credentials, were evaluated to find out the users' perceptions of their performance. One of the main conclusions of this study is that users perceived sustainable buildings to be significantly better than conventional ones, which indicates that building occupants are quite capable of assessing the performance of the buildings they occupy, and to a relatively fine degree. To summarize, the considered indicators in this study are summarized in Table 1; they were drawn from numerous conceptual frameworks and models that are built and applied in different contexts in the literature.

Table 1. Sustainability Indicators for UAE's Residential Sector.

Dimensions					
Social		Environmental		Economic	
Indicator	Label	Indicator	Label	Indicator	Label
Visual comfort	SVC	Sustainable, alternative, and renewable energy sources	EES	Initial cost	EIC
Acoustic comfort	SAC	Energy efficiency	EEE	Operation and maintenance Cost	EOM
Thermal comfort	STC	Waste management	EWM	Affordability (rent and utilities)	ERU
Indoor air quality	SIQ	Water efficiency	EWE		
Green and open spaces within the building	SGW				
Green and open spaces between buildings (neighborhood)	SGB				
Aesthetic and pleasant view	SAV				
Parking capacity	SCP				
Smart technologies	SST				
Proper (non-toxic) indoor materials	SPM				
Education and awareness	SEA				
Cultural identity	SCI				
Safety and security	SSS				
Health of occupants	SHO				
Social interaction	SSI				
Accessibility to transportation, amenities	SAT				
Accessibility for occupants with special needs	SAS				

Afterward, a validation process by experts was performed to fit the UAE's residential sector, as illustrated in Table 2. For practical purposes, four criteria were used to evaluate the indicators adopted in this research and to determine their eligibility for inclusion, where the indicators are chosen based on their relevance, recency, being the most cited in the literature, and where studies that have identified indicators must look at different contexts, not just one particular context. Table 2 indicates that this is the first study that comprehensively and simultaneously assesses the sustainability perceptions of residential occupants in the UAE in addressing the environmental, economic, and social sustainability aspects, which signifies the importance of this paper.

In addition, the initial building assessment systems were limited to basic aspects such as location, energy, water, materials, waste, pollution, and indoor environmental quality, while the new ones developed in the last decade added several categories to the field of rating systems. Most of the new systems also consider cost and economic aspects. Other added categories include safety, usability and functionality, local culture, outdoor environmental quality, impact on adjacent properties, time, low-carbon aspects, and project design aspects that have improved and enriched the existing systems. Although some building assessment systems have been proposed for some countries, no studies have been conducted to present an assessment system for buildings in other countries such as the UAE.

Moreover, Figure 2 shows the published research work in the sustainability and SD areas in the UAE. It can be observed that their importance has increased across the years, especially in the engineering, environmental, social sciences, and energy—as per Scopus research analysis, which is considered one of the premium databases and peer-reviewed journals [123].

Table 2. Extracted Indicators.

[illegible]

Table 2. Cont.

Dimensions	Indicators	References																
		[70]	[71]	[72]	[73]	[76]	[77]	[78]	[79]	[80]	[81]	[82]	[83]	[84]	[85]	[87]	[88]	[89]
Social	Visual comfort			X		X	X	X		X			X			X		X
	Acoustic comfort			X		X	X	X		X			X	X		X		X
	Thermal comfort			X		X	X	X		X			X			X		X
	Indoor air quality			X		X	X	X	X	X	X	X				X		
	Green and open spaces within the building									X								
	Green and open spaces between buildings (neighborhood)				X	X		X						X	X		X	X
	Aesthetic and pleasant view		X							X				X				
	Parking capacity									X				X		X		
	Smart technologies									X		X						
	Proper (non-toxic) indoor materials									X		X						
	Education and awareness									X				X			X	
	Cultural identity			X	X	X	X						X		X			X
	Safety and security				X			X	X				X					
	Health of occupants			X	X		X	X	X		X		X	X	X		X	X
	Social interaction						X	X					X					
	Accessibility to transportation, amenities				X	X		X	X				X		X	X	X	
	Accessibility for occupants with special needs			X														
Environmental	Sustainable, alternative, and renewable energy sources									X		X				X		
	Energy efficiency					X	X		X	X	X	X	X		X	X	X	X
	Waste management					X	X		X	X	X	X			X	X	X	X
	Water efficiency	X					X		X	X	X	X			X	X	X	X
Economic	Initial cost					X	X			X								
	Operation and maintenance Cost					X	X			X			X					
	Affordability (rent and utilities)									X	X		X		X			

Table 2. Cont.

Dimensions	Indicators	References																
		[70]	[71]	[72]	[73]	[76]	[77]	[78]	[79]	[80]	[81]	[82]	[83]	[84]	[85]	[87]	[88]	[89]
Social	Visual comfort	X	X	X	X					X	X			X		X		X
	Acoustic comfort	X	X	X	X		X			X	X					X		X
	Thermal comfort	X	X	X	X		X			X	X			X		X		X
	Indoor air quality	X	X	X	X		X			X	X					X	X	X
	Green and open spaces within the building													X				
	Green and open spaces between buildings (neighborhood)	X						X	X		X			X				X
	Aesthetic and pleasant view													X				
	Parking capacity					X												
	Smart technologies													X				
	Proper (non-toxic) indoor materials																	
	Education and awareness												X					
	Cultural identity	X						X	X		X			X				X
	Safety and security				X	X		X						X				
	Health of occupants	X			X	X		X						X				X
	Social interaction	X																X
	Accessibility to transportation, amenities			X	X	X		X	X		X			X		X		
	Accessibility for occupants with special needs													X				
Environmental	Sustainable, alternative, and renewable energy sources		X	X	X	X			X			X				X	X	
	Energy efficiency	X	X	X	X	X	X	X		X	X	X	X	X	X	X		X
	Waste management	X	X	X	X	X	X	X			X	X		X	X	X		X
	Water efficiency	X	X	X	X	X	X	X	X		X			X		X		X
Economic	Initial cost													X				
	Operation and maintenance Cost	X	X		X	X		X			X			X				X
	Affordability (rent and utilities)		X		X	X	X	X	X	X	X			X				

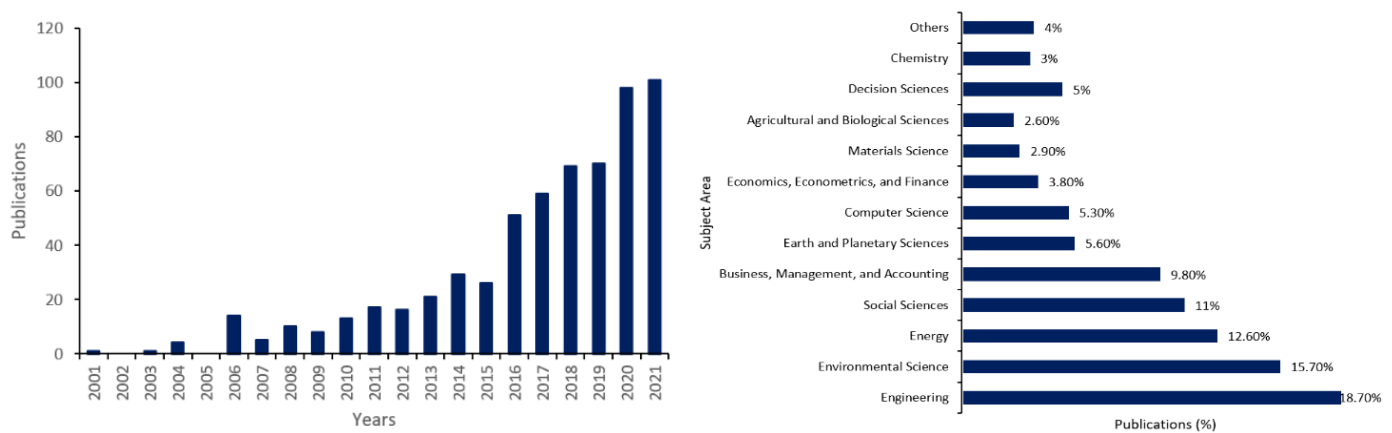


Figure 2. Annual Published Research in Sustainability and Sustainable Development per Subject Area in the UAE [123].

Table 3 illustrates a summary of studies found in the literature concerning sustainability perceptions and the methods adopted for each study in different contexts. It can be noticed that only one study took place in the UAE [124] to assess buildings as heritage, ordinary modern, or sustainable modern buildings concerning defined sustainability criteria. More importantly, none of the studies in all the different contexts, including the UAE, aimed at providing a comprehensive framework to assess the perception of the sustainability of the residential sector in the UAE, which embodies and addresses environmental, economic, and social sustainability aspects. In terms of the methods, it can be noted that none of the studies used Structural Equation Modeling (SEM) to measure sustainability perceptions. Therefore, these findings signify the importance of this paper.

Table 3. A Summary of Perception and Assessment of Sustainability Studies.

No.	Ref.	Context	Method/s	Selection Criteria		No.	Ref.	Context	Method/s	Selection Criteria	
				Lit.	GBRTs					Lit.	GBRTs
1	[69]	Spain	ANOVA *	X		20	[106]	Ireland	Descriptive Analysis	X	
2	[70]	-	Regression Analysis	X		21	[107]	Slovenia	Case Studies—MCDM	X	
3	[73]	Copenhagen	Agent Based Models	X		22	[108]	Portugal	SBTool ****	X	X
4	[76]	Kazakhstan	RSAM **	X		23	[109]	Malaysia	MCDM		X
5	[78]	Spain	Descriptive Analysis	X		24	[110]	Oman	MCDM		X
6	[79]	The Netherlands	Correlation Analysis	X		25	[111]	Sri Lanka	Correlations Analysis		X
7	[81]	Italy	Regression Analysis	X	X	26	[113]	Hong Kong	Case Studies		X
8	[85]	Italy	Descriptive Analysis	X		27	[114]	-	MCDM	X	X
9	[90]	USA	Regression Analysis	X		28	[115]	-	MCDM		X
10	[94]	Iran	MCDM ***	X		29	[116]	Australia	Descriptive Analysis	X	X
11	[96]	Pakistan	ANOVA-MCDM	X		30	[117]	Canada	Case Studies—MCDM	X	X
12	[97]	Pakistan	Cluster Analysis	X		31	[118]	Thailand	Factor Analysis	X	
13	[98]	-	MCDM	X		32	[119]	Serbia	Case Studies—MCDM	X	
14	[99]	Iran	Content Analysis		X	33	[121]	UAE	MCDM	X	
15	[101]	Kazakhstan	MCDM	X	X	34	[124]	-	MCDM		X
16	[102]	Saudi Arabia	MCDM		X	35	[125]	Iran	MCDM	X	X
17	[103]	Kazakhstan	Case Studies		X	36	[126]	-	Descriptive Analysis		X
18	[104]	-	Content Analysis		X	37	[127]	Jordan	MCDM	X	
19	[105]	Czech Republic -Australia	Case Studies								

*: Analysis of variance, **: Rapid Sustainability Assessment Method, ***: Multiple-Criteria Decision-Making, ****: Sustainable Building Tool.

In conclusion, the significance of this study lies in targeting the residential sector, which has a major influence on the environmental, social, and economic aspects due to it being the highest reported statistic in consuming energy resources in addition to contributing to greenhouse gas emissions and air pollution. Moreover, since the targeted population represents a large segment of the community, the outcomes of this study would be beneficial to policy/decision-makers, developers, contractors, designers, facility management entities, etc., to allow regulating and applying supportive sustainability practices to enhance overall sustainability in the residential sector. To the best of the authors' knowledge, this is the first study of its kind that represents a comprehensive assessment of the perception and awareness of occupants in the residential buildings in the UAE based on the TBL paradigm, which is in line with the strategic direction of the UAE towards sustainable development.

2. Materials and Methods

This section presents the research methodology in this paper to fill the literature review gap and meet the aim and objectives of this study, as demonstrated in Figure 3. The first step is concerned with defining the problem of this study to fulfill the anticipated outcomes, and this is achieved by limiting the literature review to cover the aspect of interest, which includes the related sustainability indicators that describe the perception of sustainability by occupants in the residential sector.

After collecting the previously considered indicators from several relevant studies in different countries, subject matter experts (SMEs) were involved to come up with a verified list of indicators that are applied to the context of occupants in the residential sector in the UAE; the indicators were chosen based on their applicability, relevance, recency, and being the most cited in the literature. In addition, the SMEs were consulted regarding the design of the initial survey, and to give the final validation of the questions after piloting the survey by checking the clarity of the questions and revising them accordingly.

A cross-sectional online survey was adopted by using random sampling to avoid sampling bias [128,129]; it included two sections: (i) demographic information of respondents and (ii) a set of questions to measure each sustainability indicator amongst the TBL based on a five-point Likert scale (ranging from 5 = Strongly Agree to 1 = Strongly Disagree). The survey's questions are outlined in Appendix A. In addition, after collecting the responses, several validation and reliability tests were conducted followed by applying processing techniques to prepare the data for the analysis and enhance the reliability of the results.

Consequently, several sequential analytical steps have been conducted to understand the responses, draw beneficial conclusions, and fulfill the aim of the study. These steps include: (i) descriptive data analysis, where general conclusions about the responses, their demographic information, and their overall assessment are understood, (ii) confirmatory factor analysis (CFA), used to measure—in the context of the residential sector in the UAE—how significant each indicator is to its relevant sustainability pillar (social, environmental, economic), and to confirm the existing theory regarding the correlation among the TBL of sustainability [130,131]; this can be confirmed by testing the hypothesis of having a statistical correlation among them [132], and (iii) structural equation modeling (SEM); to measure the occupants' perception of sustainability based on the statistical significant indicators that resulted from the previous step. Using the extracted indicators along with the revealed correlation among the three dimensions of sustainability, the initial model is illustrated in Figure 4.

From the figure, it can be noticed that the overall perception of sustainability of occupants in residential buildings is measured using three main variables: social, economic, and environmental pillars. The perception of sustainability is a latent variable in the model, which means that it cannot be measured directly [133].

Therefore, SEM is used to measure it by employing the responses of the survey; it serves as a statistical tool to measure the overall perception of sustainability by measuring the social, economic, and environmental pillars' contribution to overall sustainability for the targeted population (residential sector). In addition, each pillar constitutes a latent

variable that is measured through the related depicted indicators from the literature (iv) To investigate the differences in occupants' perceptions of sustainability according to their demographic characteristics, a comparative analysis (Kruskal-Wallis test) was performed in SAS. This test was used to test the differences in the overall perception of sustainability among the different class levels based on demographic information—namely age, gender, education level, employment status, monthly income for professionals, marital status, number of family members living together, accommodation type, and residence status.

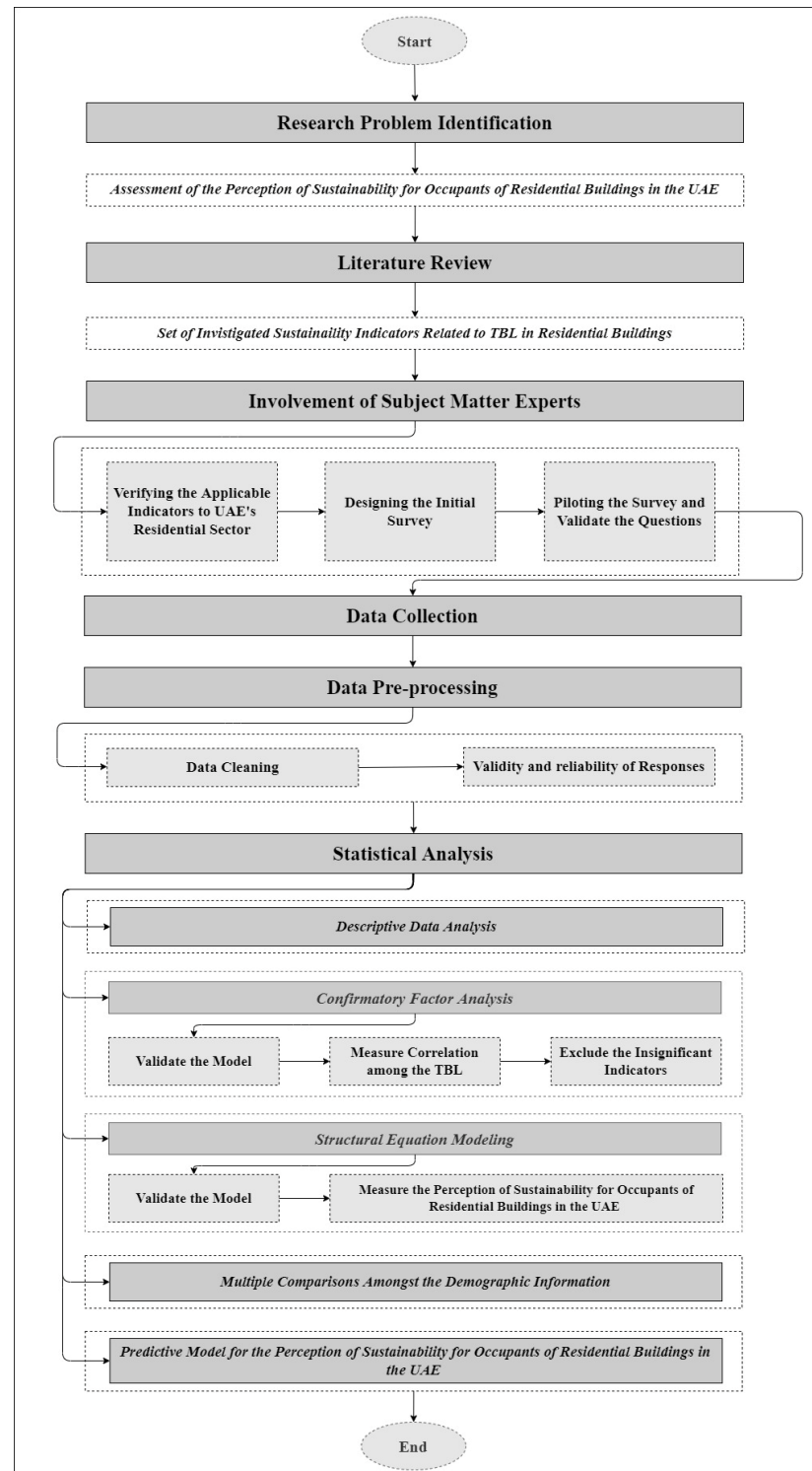


Figure 3. Research Methodology.

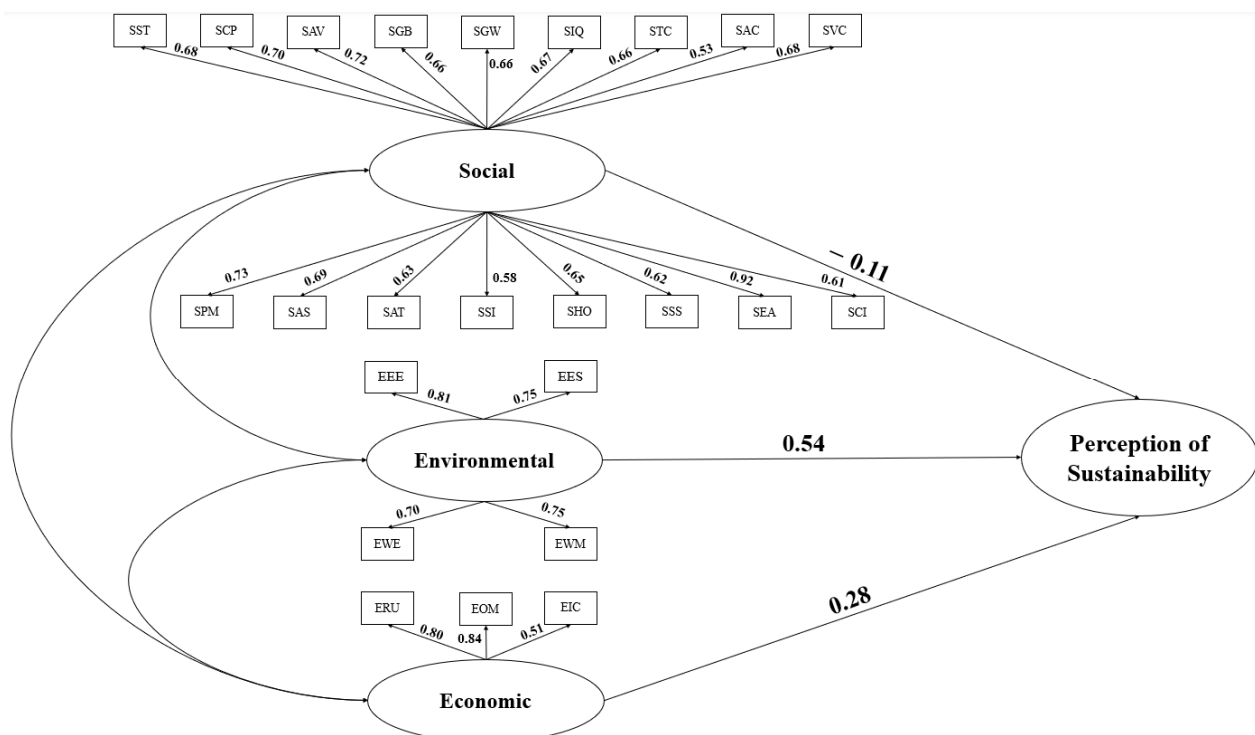


Figure 4. Initial Structural Equation Model.

Accordingly, several Kruskal-Wallis tests were conducted to test the null hypothesis (H_0 : There are no differences between the different classes) from the alternative hypothesis (H_1 : At least one class level is significantly different). Accordingly, multiple comparison tests were performed using PROC GLM in SAS to identify the sources of the differences. Least squares mean differences and confidence intervals were also used to gain further insight, and finally, (v) building a predictive model for the perception of sustainability based on the collected data of occupants, where the results from each of the aforementioned steps contribute to the benefits of the associated stakeholders including policy /decision-makers, developers, contractors, designers, facility management entities, etc., and allow regulating and applying supportive sustainability practices to enhance the overall sustainability in the residential sector.

3. Results

Since there are differences in the age and educational background of the target audiences, it is possible that some terms are not well understood by a variety of people in the targeted population. Therefore, the survey began by defining perception, sustainability, social sustainability, environmental sustainability, and economic sustainability to clarify these terminologies and thus minimize sample bias that might result from such differences in respondents' backgrounds. In addition, administration bias was reduced by conducting online surveys, which increases respondent transparency and avoids any interviewer influence, as participants are more likely to display a positive attitude toward an interviewer [134,135]. Additionally, each indicator was represented by a question in the survey. The survey was distributed online for one month (March 2022), targeting people in the residential sector in the UAE regardless of their backgrounds, nationalities, educational levels, etc. In total, 406 responses were received, and they are fully completed. The following subsections represent the results for each part of the analysis.

3.1. Respondents' Demographic Information

The demographic information for the respondents is summarized in Table 4. It can be observed that the majority of respondents are females (70%), which implies that females

tend to complete online surveys more than males; this was noticed by several researchers as females have a higher response rate for such surveys than males [136,137]. For the age groups of respondents, it was found that 79% of respondents are more than 30 years old, 15% are between 25–30 years old, and 6% are less than 25 years old. In addition, most respondents are married (80%), and most of the respondents' family members who live in the same house range from 2–7 in number, with around 48% of them having 2–4 members and 41% having 5–7 members. Regarding the educational level, 68% of the respondents hold a bachelor's degree, 22.6% hold a master's degree, and the remaining are high-schooled (4.4%), Ph. Ds. (4.5%), and the unschooled yields the lowest percentage (0.5%).

Table 4. Demographic Information.

No.	Demographics	%	No.	Demographics	%
1	Gender		6	Employment Status	
	Male	30.0		Unemployed	30.8
	Female	70.0		Employed	49.7
2	Age			Business Owner	13.5
	18–24	6.0		Student	4.2
	25–30	15.0		Retired	1.8
	31–40	41.0	7	Number of Family Members Living Together	
	41 or older	38.0		1	7.4
3	Marital Status			2–4	47.8
	Single	17.2		5–7	41.4
	Married	80.3		More than 7	3.4
	Divorced	2.5	8	Accommodation Type	
4	Education Level			Rental House	28.8
	Unschool	0.5		Rental Apartment	49.3
	High School	4.4		Owned House	16.0
	Bachelor's Degree	68.0		Owned Apartment	5.9
	Master's Degree	22.6	9	Monthly salary Range "if employed"	
	Ph.D.	4.5		Less than AED15,000	43.0
5	Current Residency Status			AED15,000–AED25,000	19.6
	Local	25.0		AED25,001–AED35,000	14.0
	Expat	75.0		AED35,001–AED45,000	10.0
				More than AED45,000	13.4

Nevertheless, around 31% of the respondents are unemployed, which might be represented by housewives, since the majority are females and married. However, almost half of the respondents are employed, while the remaining are business owners, students, or retired. Interestingly, 78% of the respondents live in rental accommodations, which might be justified by the percentage of expat respondents (75%) as they tend to live in rental accommodations, unlike the local people. For monthly income, 43% of respondents earn less than AED15k, around 20% earn AED15k–25k, 14% earn AED25k–35k, 10% earn AED35k–45k, and the remaining (13%) earn more than AED45k.

3.2. Data Validation

Testing the validity and reliability of the data is a crucial step prior to starting the analysis. Since the responses are of a qualitative nature, the survey's questions were reviewed and amended by SMEs to avoid bias in the questions' formulation [138]. Moreover, random distribution (sampling) of the survey was conducted as another action toward bias avoidance [139], and several measures are taken to test the collected data and ensure their suitability for the required analysis. Firstly, the analysis in this paper requires an adequate sample size, hence, Kaiser-Meyer-Olkin (KMO) test is conducted, where any value between 0.7 and 1 implies that the data is adequate for the analysis [140]. The

KMO value of the collected data in this paper is 0.95, which indicates that the sample size is adequate. Secondly, to test the reliability of the collected data, Cronbach's α and composite reliability (CR) are measured for each construct (social, environmental, and economic) [141]. Cronbach's α is used to test the internal consistency of responses, while CR is recommended when applying SEM to test how each indicator is related to the other within the same construct. Table 5 shows the values for the correlation between each indicator and other indicators within the same dimension, which shows that there is a correlation among the indicators within each dimension. It is vital to check the correlation among indicators of each dimension as they are assumed to be correlated and coordinately contribute to the measurement of the related dimension [142,143]. Furthermore, Cronbach's α and CR values range between 0.75 and 0.93, which indicates a high acceptance level for the data; hence, it can be used in the analysis with the set of indicators shown in Table 5.

Table 5. Data Validation.

Dimensions	Correlation within Each Dimension	Cronbach's α	CR
Social Sustainability		0.934899	0.933204
SVC	0.679425		
SAC	0.530025		
STC	0.674074		
SIQ	0.660227		
SGW	0.643177		
SGB	0.670736		
SAV	0.704612		
SCP	0.643326		
SST	0.660699		
SPM	0.705919		
SEA	0.890951		
SCI	0.585643		
SSS	0.589520		
SHO	0.637328		
SSI	0.578443		
SAT	0.619643		
SAS	0.634990		
Environmental Sustainability		0.843111	0.842117
EES	0.677030		
EEE	0.724276		
EWM	0.694750		
EWE	0.616997		
Economic Sustainability		0.757581	0.767014
EIC	0.463926		
ERU	0.657470		
EOM	0.653138		

3.3. Confirmatory Factor Analysis

The CFA is concerned with analyzing the covariance structure of the model. This step helps in testing the goodness of fit for the model, the correlation among the main constructs, and the significance of each indicator within the related construct. After analyzing the covariance structure of the model in Figure 4, the goodness of fit values indicates a statistically acceptable fit where the goodness of fit index (GFI) = 0.9097, the adjusted goodness of fit index (AGFI) = 0.8827, and the Bentler comparative fit index (CFI) = 0.9529, while the standardized root mean square residual (SRMR) error shows an acceptable error (<0.05) with a value of 0.0476.

Additionally, Table 6 shows the CFA results. It is noticed that all the indicators are significant within each construct, with a standardized estimate that is higher than 0.5 and a p -value that indicates statistical significance (<0.0001). Moreover, from the

covariance matrix of the three main constructs, there is a significant correlation between social, economic, and environmental sustainability, as demonstrated in Table 7.

Table 6. CFA Results.

Social Sustainability			Environmental Sustainability			Economic Sustainability		
Indicators	Standardized Estimates	p-Value	Indicators	Standardized Estimates	p-Value	Indicators	Standardized Estimates	p-Value
SVC	0.68022	<0.0001	EES	0.75539	<0.0001	EIC	0.50280	<0.0001
SAC	0.52838	<0.0001	EEE	0.81617	<0.0001	ERU	0.79835	<0.0001
STC	0.66343	<0.0001	EWM	0.75498	<0.0001	EOM	0.84390	<0.0001
SIQ	0.66590	<0.0001	EWE	0.69443	<0.0001			
SGW	0.65593	<0.0001						
SGB	0.66042	<0.0001						
SAV	0.71592	<0.0001						
SCP	0.69320	<0.0001						
SST	0.68110	<0.0001						
SPM	0.72534	<0.0001						
SEA	0.92299	<0.0001						
SCI	0.61395	<0.0001						
SSS	0.62090	<0.0001						
SHO	0.64899	<0.0001						
SSI	0.58250	<0.0001						
SAT	0.63427	<0.0001						
SAS	0.68888	<0.0001						

Table 7. Standardized Covariance Matrix.

	Social	Environmental	Economic
Social		0.65126 <0.0001	0.66354 <0.0001
Environmental			0.59156 <0.0001
Economic			

3.4. Structural Equation Modelling

The SEM was performed to measure how overall sustainability is perceived by the represented population by evaluating the impact of each sustainability pillar (economic, social, and environmental) on the overall sustainability. Each indicator was represented by a question in the survey, and SEM employs the qualitative responses to each indicator to measure the unmeasurable variables (social, economic, and environmental sustainability). Afterward, these variables are used to measure the overall perception of sustainability based on their standardized estimate values and their statistical significance [144]. This analysis is conducted by fitting the hypothetical model that is demonstrated in Figure 4 using PROC CALIS in SAS software; the results from the SEM analysis are illustrated in Table 8.

The covariance matrix of the indicators is used in this analysis [132,145] as the model is based on the existing theory that needs to be tested using the following hypotheses:

Hypothesis 1 (H1). *Social sustainability has a positive impact on the perception of overall sustainability for occupants in the residential sector in the UAE.*

Hypothesis 2 (H2). *Environmental sustainability has a positive impact on the perception of overall sustainability for occupants in the residential sector in the UAE.*

Hypothesis 3 (H3). *Economic sustainability has a positive impact on the perception of overall sustainability for occupants in the residential sector in the UAE.*

Table 8. SEM Results.

	Path		Estimate	p-Value
Social	→	SVC	0.67995	<0.0001
Social	→	SAC	0.52814	<0.0001
Social	→	STC	0.66252	<0.0001
Social	→	SIQ	0.66659	<0.0001
Social	→	SGW	0.65593	<0.0001
Social	→	SGB	0.66043	<0.0001
Social	→	SAV	0.71602	<0.0001
Social	→	SCP	0.69297	<0.0001
Social	→	SST	0.68080	<0.0001
Social	→	SPM	0.72538	<0.0001
Social	→	SEA	0.92350	<0.0001
Social	→	SCI	0.61375	<0.0001
Social	→	SSS	0.62161	<0.0001
Social	→	SHO	0.64897	<0.0001
Social	→	SSI	0.58221	<0.0001
Social	→	SAT	0.63420	<0.0001
Social	→	SAS	0.68928	<0.0001
Environmental	→	EES	0.75078	<0.0001
Environmental	→	EEE	0.80843	<0.0001
Environmental	→	EWM	0.75115	<0.0001
Environmental	→	EWE	0.70489	<0.0001
Economic	→	EIC	0.50969	<0.0001
Economic	→	ERU	0.80336	<0.0001
Economic	→	EOM	0.83967	<0.0001
(H1) Social	→	Sustainability	−0.10631	0.1047
(H2) Environmental	→	Sustainability	0.53691	<0.0001
(H3) Economic	→	Sustainability	0.27513	<0.0001

The model fit indicates an acceptable fit with a GFI = 0.9078, AGFI = 0.8802, CFI = 0.9523, and SRMR = 0.0474. From the results in Table 8, it is revealed that each indicator is significant within each construct with a positive standardized estimate and significant *p*-value. Nevertheless, it is concluded that the overall sustainability of occupants in the residential sector in the UAE is significantly and positively impacted by environmental and economic sustainability aspects (H2 and H3), while social sustainability (H1) plays an insignificant role in defining and understanding the overall sustainability for this targeted population. Furthermore, the impact of environmental sustainability is more intense than the impact of economic sustainability, which would refer to the traditional perception of defining sustainability in terms of environmental aspects.

3.5. Comparative Analysis

Multiple comparative processes are conducted among the different categories of demographic information. The purpose of this comparison is to test if there is any difference in perceiving or understanding the concept of sustainability based on the demographic attributes; these comparisons are carried out using the nonparametric Kruskal test in SAS software. The results of this test are shown in Table 9; from the *p*-values, it can be seen that gender, educational level, employment status, and monthly income categories differ in their perception of sustainability, while age, marital status, family members, accommodation type, and residency status categories have not shown any significant difference in their perception of sustainability.

Additionally, pairwise comparisons are done using PROC GLM in SAS for the attributes where a significant statistical difference is found among their categories. Pairs with significant *p*-values (<0.05) are shown in Table 10. Differences between least-square means and 95% simultaneous confidence limits for differences were reported and illustrated in Table 10. The difference in least-square means shows that a higher educational level contributes positively to the perception of sustainability; this finding confirms the vital role

of education in perceiving sustainability and that more schooling years would lead to a higher probability of taking sustainable actions, as suggested by [146]. Therefore, including this factor as an indicator for sustainability assessment is extremely important and should not be ignored.

Table 9. Comparative Analysis.

Demographic Groups	<i>p</i> -Value
Gender	<0.0001
Age	0.1916
Educational Level	<0.0001
Employment Status	0.0020
Marital Status	0.5929
Family Members Living Together	0.1497
Accommodation Type	0.1512
Residency Status	0.4578
Monthly Income	0.0026

Table 10. Pairwise Comparison.

Class	Levels Comparison		Difference between Least Squares Means LSMean(i)-LSMean(j)	Simultaneous 95% Confidence Limits for Difference		<i>p</i> -Value
	i	j		Lower Limit	Upper Limit	
Gender	Males	Females	61.402	39.113	83.690	<0.0001
Educational Level	Bachelor's degree	Master's degree	−117.709	−187.705	−47.713	<0.0001
	Bachelor's degree	Ph.D. degree	−190.960	−260.174	−121.746	<0.0001
	Master's degree	Ph.D. degree	−73.251	−99.853	−46.649	<0.0001
Employment Status	Unemployed	Employed	−35.750	−69.986	−1.515	0.033
	Unemployed	Business Owners	−61.890	−110.569	−13.212	0.004
Monthly Income (AED)	Below 15,000	35,000–45,000	−62.366	−108.771	−15.960	0.0017

With regards to employment status, the analysis shows a significant difference between the unemployed and employed participants as well as the unemployed and business owners, with *p*-values of 0.0276 and 0.0051, respectively, where the difference in least-square means shows that the effect size of employed and business owners is higher than unemployed participants. These findings validate the fact that the UAE is one of the pioneering countries in adopting sustainability practices and regulating the behavior of companies and business owners by raising their awareness of sustainability. In addition, most workplaces in the UAE provide specialized training to improve employees' perception of sustainability and sustainable development [147,148]. The previous findings also justify the significant difference in the level of awareness between males and females, where males' data showed better results in terms of perceiving sustainability, as most of the unemployed respondents were females.

Similarly, pairwise comparisons among monthly income levels show that there is a significant difference in perceptions between low-income participants (below AED15k) and high-income participants (AED35k–AED45k), with high-income participants scoring higher least-square means in the perception of sustainability. This confirms the existence of a good balance between economic growth and environmental-social aspects of sustainability in the UAE. Such a balance was observed in several studies in Portugal, China, and

Indonesia [149–151], as an essential factor to pave the way to a realistic path toward sustainable development.

3.6. Predicting the Perception of Sustainability for Occupants of Residential Sector in the UAE

In this part, the perception of the sustainability concept is predicted for occupants of the residential sector in the UAE. The proposed predictive models aim to predict whether the sustainability concept is perceived or not by building a function of all their demographic attributes. Since the output variable is categorical (perceived, not perceived), the prediction takes the form of classification. The collected dataset is used to train the model that represents the relationship between the attributes of occupants (demographic information) and the output (perceived, not perceived), and once the model is built, it can be used for prediction.

The dataset is divided into two sets—training and testing; the training dataset is 75% of the original dataset, while the testing is 25%. The training part is used for fitting the model, which will be applied to the testing dataset for assessing the performance of the prediction. In this paper, decision tree (DT) algorithms are applied for predictions; these models are easy to understand, construct, and interpret, and they are also inexpensive, extremely fast in classifying, robust to noise, and can handle redundant attributes [152–155]. Three decision tree algorithms are used—logistic regression, CART, and C4.5—where each one uses a different technique to choose what attribute to split and what inputs to split upon them; thus, each algorithm provides a different decision tree.

Moreover, this analysis is conducted using the CARET package in the R software, where nine predictors are used from the demographic attributes to predict an output of two classes; sustainability is perceived, or not perceived. Cross-validation with 10 folds is used for resampling; Table 11 shows the accuracy for each algorithm. The results indicate good and similar values for the training and testing accuracies in each algorithm, which implies that the model performs well for both training and testing. This indicates that the models are neither over-fitted nor under-fitted; nevertheless, the highest accuracy is for CART algorithm (80.77%). It is important to highlight that the accuracy can be significantly improved if the dataset has more records; with more data points the training model and the testing model will perform better.

Table 11. DT Algorithms Results.

Decision Tree Algorithm	Train Method	Accuracy	
		Training	Testing
CART	rpart	78.48%	80.77%
Logistic Regression	glm	78.06%	78.21%
C4.5	J48	78.02%	78.06%

4. Discussion

Building on the sustainability literature, the present study investigated the perception of sustainability in the residential sector in the UAE. The residential sector is multi-faceted, and it influences the three main pillars of sustainability, namely: economy, environment, and social. In countries that focus on sustainability initiatives through their policies, programs, and projects, policymakers and associated entities must understand the perception of stakeholders in all sectors, especially the residential sector which is on the top of high energy-consuming sectors. The UAE is among the countries in the world that prioritize sustainability and puts intensive initiatives towards achieving it.

Of the various insightful findings of the study, one is a significant correlation among the social, economic, and environmental sustainability pillars. This result confirms the findings in previous studies in different parts of the world, such as Spain [156], Sweden [40], Poland [157], Korea [158], and Ukraine and other EU countries [159,160], that there is a clear and significant correlation between economic, social, and environmental dimensions

of sustainable development. Another key finding of this research is that, overall, the survey respondents indicated that sustainability is significantly and positively impacted by environmental and economic aspects. However, their responses clearly showed that they do not perceive the impacts of the social aspect of sustainability. These findings are consistent with previous research suggesting that the social dimension is the least perceived aspect of sustainability, compared to the environmental and economic dimensions [160].

Moreover, the results showed that the impact of environmental sustainability is more intense than the impact of economic sustainability, which is in line with the literature [40]. In this regard, Zwickle et al. [161] noted that this is because the social dimension is the most elusive pillar of the TBL and that economic sustainability is similarly under-assessed. In addition, Anderson [162] justified this assessment by the strong influence of the media on the perception and policy agendas regarding global warming and climate change. To have effective and practical sustainable practices, this study suggests adopting a balanced approach in which environmental issues are harmonized with economic and the social issues. Interestingly, the results of the comparative analysis indicated that a higher educational level contributes positively to the perception of sustainability. This finding is in accordance with recent studies [146], indicating the fundamental role of education in perceiving sustainability. This would lead to increased awareness, and therefore, enhance attitudes and sustainable behaviors.

Additionally, the results also showed a significant difference between unemployed and employed respondents in perceiving sustainability. In agreement with this result, previous studies have demonstrated that with better employee training, employees are more aware of the need for environmental control, and increase their ability to adapt to change and develop a proactive attitude toward sustainability issues [163]. This is also evident in the UAE, where building awareness and capacity across stakeholders and regular workshops are organized in most workplaces [147,148].

The previous findings regarding employment justify the significant difference in the level of awareness between males and females, where males' data showed better results in terms of perceiving sustainability; this would relate to the fact that most of the unemployed respondents were females. However, previous studies have found that awareness of sustainability does not vary by gender [164,165]. Nevertheless, other studies such as Glass et al. [166] and Kassinis et al. [167] noted that women tend to demonstrate a stronger commitment and tend to be more aware and concerned about sustainable behavior than men. In terms of monthly income, high-income participants have a higher level of perception of sustainability than low-income participants; this highlights the balance between economic growth and socio-environmental aspects of sustainability in the UAE. Prior studies in different parts of the world such as Portugal [149], China [150], and Indonesia [151] have noted the importance of this balance as being a crucial factor to pave the way towards sustainability. Nonetheless, Leiserowitz et al. [168], Bloodhart [169], and Harlan et al. [170] have found that wealthy societies are characterized by overconsumption, materialism, and unsustainable lifestyles.

5. Conclusions and Future Work

This study set out to determine the perception of occupants in residential buildings in the UAE based on the three-pillar paradigm (environmental–economic–social). Each of these pillars is measured by deducing indicators from relevant studies in different countries and validating them by the SMEs. Overall, it was found that the three pillars of sustainability are correlated; the perception of sustainability is more significantly influenced by economic and environmental aspects than by social aspect in the residential sector in the UAE. Moreover, the conducted comparative analysis showed that there is a statistical difference among the multiple demographic attributes including gender, educational level, employment status, and monthly income. Lastly, a predictive classification model was built to predict whether the sustainability concept is perceived or not by the targeted population. This study makes several theoretical and practical contributions.

In terms of theoretical contributions, the research formulated a novel comprehensive framework to assess the perception of sustainability of the residential sector in the UAE, which embodies and addresses environmental, economic, and social sustainability aspects. In addition, the framework can also be useful for defining performance indicators for sustainability assessment frameworks and can be integrated into multi-criteria decision methods to improve sustainability and performance. In terms of practical contributions, the theme of this study is closely integrated with the status quo and planning of sustainable development in the UAE. In this research, planners and policymakers can utilize this framework of sustainability perceptions to make decisions on designing and constructing residential building projects that would enhance the sustainability perception and awareness of the occupants. Furthermore, this framework would be beneficial to policy/decision-makers, developers, contractors, designers, and facility management entities to enhance the overall sustainability in the residential sector.

For future work, it is recommended to collect more data for the predictive model to enhance its accuracy and usefulness. In addition, the study can be conducted in other countries with similar demographic attributes such as GCC as well as dissimilar countries to either validate the findings or withdraw new insights. Furthermore, this study is based on data from a single industrial setting, i.e., the residential industry in UAE. Therefore, including other industries would result in different findings and insights regarding the perception of sustainability.

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Appendix A. Survey Form

Assessment of the Perception of Sustainability for Occupants of Residential Buildings: A Case Study in the UAE.

The aim of this study is to measure the sustainability perceptions of occupants of the residential sector in the UAE. The outcomes of this study have important implications for policy and practice that are beneficial to policy/decision-makers.

Your answers will be confidential and not traced to you in person.

Below are main definitions that are helpful to better understand the survey's questions:

Perception: the ability to become aware of something.

Environmental Sustainability: Aims to improve human wellbeing through the protection of natural resources by efficient consumption.

Economic Sustainability: Aims to improve the standard of living by using resources efficiently and responsibly.

Social Sustainability: Aims to protect and improve health and wellbeing by promoting both physical and mental aspects in communities.

Thank you for helping fill out the survey.

1. Gender:

- ☐ Female
- ☐ Male

2. **Age:**
 - ☐ 18–24
 - ☐ 25–30
 - ☐ 31–40
 - ☐ Above 40
3. **Educational Level:**
 - ☐ Unschooled
 - ☐ High school
 - ☐ Bachelor's degree
 - ☐ Master's degree
 - ☐ Ph.D.
4. **Employment status:**
 - ☐ Employed
 - ☐ Unemployed
 - ☐ Business Owner
 - ☐ Student
 - ☐ Retired
5. **If employed, your monthly income is:**
 - ☐ Below AED 15,000
 - ☐ AED 15,000—AED 25,000
 - ☐ AED 25,001—AED 35,000
 - ☐ AED 35,001—AED 45,000
 - ☐ More than AED 45,000
6. **Marital status:**
 - ☐ Single
 - ☐ Married
 - ☐ Divorced
7. **Number of the family members living together:**
 - ☐ 1
 - ☐ 2–4
 - ☐ 5–7
 - ☐ More than 7
8. **Accommodation Type:**
 - ☐ Rental house
 - ☐ Rental apartment
 - ☐ Owned house
 - ☐ Owned apartment
9. **Your current residency situation**
 - ☐ Expat
 - ☐ Local
10. **Visual comfort (natural daylight, color contrast, artificial lights, etc.) in the house improves the health and wellbeing of occupants**
 - ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
11. **Acoustic comfort (acceptable level of noise) in the house improves the health and wellbeing of occupants**
 - ☐ Strongly agree

- ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
12. **Thermal comfort (acceptable temperature) in the house improves the health and wellbeing of occupants**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
13. **High indoor air quality in the house improves the health and wellbeing of occupants**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
14. **Having greenery and open spaces (balconies and terraces) within the house environment improves the health and wellbeing of occupants**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
15. **Having adequate green open spaces in the neighborhood improves the health and wellbeing of occupants**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
16. **Aesthetic aspects of the building and the neighborhood along with having pleasant views improves the health and wellbeing of occupants**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
17. **Having sufficient parking capacity is an important factor for occupants' satisfaction in residential buildings**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
18. **Having smart technologies (air filtration, temperature, humidity, sanitation, etc.) contributes to improving the health and wellbeing of occupants**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral

- ☐ Disagree
 - ☐ Strongly disagree
19. **Having non-toxic indoor materials (painting, wall coating, etc.) contributes to improving the health and wellbeing of occupants**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
20. **Your cultural habits, values, and beliefs contribute positively to the perception of sustainability**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
21. **High level of safety and security is an important factor for occupants in the residential sector**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
22. **Ensuring good overall health and wellbeing status (mental and physical) for occupants is an important factor in residential sector**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
23. **Social interaction within the house and/or with the neighborhood contribute positively to occupants' satisfaction and well-being**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
24. **Accessibility to amenities and public transportation is an important factor for occupants in residential sector**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
25. **General accessibility (ramps, elevators, parking, etc.) for occupants with special needs is an important factor in residential sector**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree

26. **Based on the above, how well do you describe your overall perception of social responsibility in the residential sector?**
- ☐ Strongly perceived/understood
 - ☐ Perceived/understood
 - ☐ Neutral
 - ☐ Not perceived/not understood
 - ☐ Strongly not perceived/not understood
27. **Would you consider relying on alternative and renewable energy resources in your house; to avoid the negative environmental impacts?**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
28. **Would you consider using energy-efficient/saving appliances in your house; to avoid the negative environmental impacts?**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
29. **Would you consider implementing waste management techniques (such as waste separation or recycling), in your house; to avoid the negative environmental impacts?**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
30. **Would you apply measures (such as tap sensors/extenders) in your house; to enhance the efficiency of water use and avoid wasting water?**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
31. **Based on the above, how well do you describe your overall perception of environmental responsibility in the residential sector?**
- ☐ Strongly perceived/understood
 - ☐ Perceived/understood
 - ☐ Neutral
 - ☐ Not perceived/not understood
 - ☐ Strongly not perceived/not understood
32. **Would you consider the monetary value of sustainability practices in your budget when you want to buy a house?**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree

33. **The rent of the house and cost of utilities (water, electricity, services, etc.) are influential factors when you want to rent/buy a house.**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
34. **The operation and maintenance cost of the house is an influential factor when you want to rent/buy.**
- ☐ Strongly agree
 - ☐ Agree
 - ☐ Neutral
 - ☐ Disagree
 - ☐ Strongly disagree
35. **Based on the above, to what extent do you agree that economic responsibility is well perceived and understood in the residential sector?**
- ☐ Strongly perceived/understood
 - ☐ Perceived/understood
 - ☐ Neutral
 - ☐ Not perceived/not understood
 - ☐ Strongly not perceived/not understood
36. **How well do you describe you overall perception of sustainability in the residential sector?**
- ☐ Strongly perceived/understood
 - ☐ Perceived/understood
 - ☐ Neutral
 - ☐ Not perceived/not understood
 - ☐ Strongly not perceived/not understood

References

1. Curren, R.; Metzger, E. *Living Well Now and in the Future: Why Sustainability Matters*; MIT Press: Cambridge, MA, USA, 2017.
2. Caradonna, J.L. *Sustainability: A History*; Oxford University Press: Oxford, UK, 2014.
3. Kuhlman, T.; Farrington, J. What is sustainability? *Sustainability* **2010**, *2*, 3436–3448. [\[CrossRef\]](#)
4. Glavič, P.; Lukman, R. Review of sustainability terms and their definitions. *J. Clean. Prod.* **2007**, *15*, 1875–1885. [\[CrossRef\]](#)
5. Brundtland, G.H.; Khalid, M. *Our Common Future*; Oxford University Press: Oxford, UK, 1987.
6. Elkington, J.; Rowlands, I.H. Cannibals with forks: The triple bottom line of 21st century business. *Altern. J.* **1999**, *25*, 42.
7. Mahmoudi, R.; Rasti-Barzoki, M. Sustainable supply chains under government intervention with a real-world case study: An evolutionary game theoretic approach. *Comput. Ind. Eng.* **2018**, *116*, 130–143. [\[CrossRef\]](#)
8. Bragança, L.; Mateus, R.; Koukari, H. Building sustainability assessment. *Sustainability* **2010**, *2*, 2010–2023. [\[CrossRef\]](#)
9. Al Waer, H.; Sibley, M. Building sustainability assessment methods: Indicators, applications, limitations and development trends. In Proceedings of the Conference on Sustainable Building South East Asia, Kuala Lumpur, Malaysia, 11–13 April 2005; pp. 1–13.
10. Giusti, L.; Almoosawi, M. Impact of building characteristics and occupants' behaviour on the electricity consumption of households in Abu Dhabi (UAE). *Energy Build.* **2017**, *151*, 534–547. [\[CrossRef\]](#)
11. Radhi, H. Evaluating the potential impact of global warming on the UAE residential buildings—A contribution to reduce the CO₂ emissions. *Build. Environ.* **2009**, *44*, 2451–2462. [\[CrossRef\]](#)
12. Lin, M.; Afshari, A.; Azar, E. A data-driven analysis of building energy use with emphasis on operation and maintenance: A case study from the UAE. *J. Clean. Prod.* **2018**, *192*, 169–178. [\[CrossRef\]](#)
13. Krarti, M.; Dubey, K. Review analysis of economic and environmental benefits of improving energy efficiency for UAE building stock. *Renew. Sustain. Energy Rev.* **2018**, *82*, 14–24. [\[CrossRef\]](#)
14. Chartrand, T.L. The role of conscious awareness in consumer behavior. *J. Consum. Psychol.* **2005**, *15*, 203–210. [\[CrossRef\]](#)
15. Buerke, A.; Straatmann, T.; Lin-Hi, N.; Müller, K. Consumer awareness and sustainability-focused value orientation as motivating factors of responsible consumer behavior. *Rev. Manag. Sci.* **2017**, *11*, 959–991. [\[CrossRef\]](#)
16. Figueiredo, K.; Pierott, R.; Hammad, A.W.A.; Haddad, A. Sustainable material choice for construction projects: A life cycle sustainability assessment framework based on BIM and Fuzzy-AHP. *Build. Environ.* **2021**, *196*, 107805. [\[CrossRef\]](#)

17. Nematchoua, M.K.; Sadeghi, M.; Reiter, S. Strategies and scenarios to reduce energy consumption and CO₂ emission in the urban, rural and sustainable neighbourhoods. *Sustain. Cities Soc.* **2021**, *72*, 103053. [CrossRef]
18. Bernardi, E.; Carlucci, S.; Cornaro, C.; Bohne, R.A. An Analysis of the Most Adopted Rating Systems for Assessing the Environmental Impact of Buildings. *Sustainability* **2017**, *9*, 1226. [CrossRef]
19. American Leadership on the Sustainable Development Goals. 2015. Available online: https://unfoundation.org/what-we-do/issues/sustainable-development-goals/u-s-leadership-on-the-sdgs/?gclid=CjwKCAiA9aKQBhBREiwAyGP5laeQRDWRzR4W9Ny1VLuO1PLn-omTcjx9MamO_6OtK3zpbwZMQXOr7RoC2PQQAvD_BwE (accessed on 22 September 2020).
20. Sustainability Development Goals. 2020. Available online: <https://www.moccae.gov.ae/en/about-ministry/about-the-ministry/sustainability-development-goals.aspx> (accessed on 22 September 2020).
21. UAE Sustainability Initiatives. 2020. Available online: <https://emiratesgbc.org/uae-sustainability-initiatives/> (accessed on 22 September 2020).
22. ESTIDAMA. ESTIDAMA-Pearl Building Rating System. Available online: <https://pages.dmt.gov.ae/en/Urban-Planning/Pearl-Building-Rating-System> (accessed on 12 February 2022).
23. Government_of_Dubai. Al Sa'fat—Dubai Green Building System. Available online: <https://www.dm.gov.ae/municipality-business/al-safat-dubai-green-building-system/> (accessed on 12 February 2022).
24. MASDAR. MASDAR City. Available online: <https://masdarcity.ae/> (accessed on 12 February 2022).
25. The_Sustainable_City. The Sustainable City—Dubai. Available online: <https://www.thesustainablecity.ae/home/> (accessed on 12 February 2022).
26. Sharjah_Sustainable_City. Sharjah Sustainable City. Available online: <https://www.sharjahsustainablecity.ae/en/> (accessed on 12 February 2022).
27. EXPO2020. EXPO2020—Dubai—UAE. Available online: <https://www.expo2020dubai.com/> (accessed on 12 February 2022).
28. Government_of_Dubai. Mohammed Bin Rashid Al Maktoum Solar Park. Available online: <https://www.dewa.gov.ae/en/about-us/media-publications/latest-news/2019/03/mohammed-bin-rashid-al-maktoum-solar-park> (accessed on 12 February 2022).
29. UAE SGDs Initiatives and Projects. 2022. Available online: <https://uaesdgs.ae/en/initiatives> (accessed on 22 September 2020).
30. SDR. United Arab Emirates—Overall Score. 2021. Available online: <https://dashboards.sdgindex.org/profiles/united-arab-emirates> (accessed on 12 February 2022).
31. Asif, M. Growth and sustainability trends in the buildings sector in the GCC region with particular reference to the KSA and UAE. *Renew. Sustain. Energy Rev.* **2016**, *55*, 1267–1273. [CrossRef]
32. Chan, A.P.C.; Adabre, M.A. Bridging the gap between sustainable housing and affordable housing: The required critical success criteria (CSC). *Build. Environ.* **2019**, *151*, 112–125. [CrossRef]
33. United Nations Environmental Programme. *Buildings and Climate Change: Summary for Decision-Makers*; Sustainable Buildings and Climate Initiative (SBCI): Paris, France, 2009; pp. 1–62.
34. CEIC Data. United Arab Emirates Electricity Consumption: Dubai: Residential. Available online: <https://www.ceicdata.com/en/united-arab-emirates/electricity-consumption/electricity-consumption-dubai-residential#:~:text=United%20Arab%20Emirates%20Electricity%20Consumption%3A%20Dubai%3A%20Residential%20data%20is%20updated,of%202%2C910.000%20GWh%20in%201997> (accessed on 14 January 2021).
35. Cuadrado, D.; Salgado, J.F.; Moscoso, S. Prevalence and Correlates of Academic Dishonesty: Towards a Sustainable University. *Sustainability* **2019**, *11*, 6062. [CrossRef]
36. Liu, J.; Dietz, T.; Carpenter Stephen, R.; Alberti, M.; Folke, C.; Moran, E.; Pell Alice, N.; Deadman, P.; Kratz, T.; Lubchenco, J.; et al. Complexity of Coupled Human and Natural Systems. *Science* **2007**, *317*, 1513–1516. [CrossRef]
37. Howell, R.A. Carbon management at the household level: A definition of carbon literacy and three mechanisms that increase it. *Carbon Manag.* **2018**, *9*, 25–35. [CrossRef]
38. Garbie, I.H. Sustainability Awareness in Industrial Organizations. *Procedia CIRP* **2015**, *26*, 64–69. [CrossRef]
39. Oriade, A.; Osinaike, A.; Aduhene, K.; Wang, Y. Sustainability awareness, management practices and organisational culture in hotels: Evidence from developing countries. *Int. J. Hosp. Manag.* **2021**, *92*, 102699. [CrossRef]
40. Berglund, T.; Gericke, N. Separated and integrated perspectives on environmental, economic, and social dimensions—an investigation of student views on sustainable development. *Environ. Educ. Res.* **2016**, *22*, 1115–1138. [CrossRef]
41. Zeegers, Y.; Clark, I.F. Students' perceptions of education for sustainable development. *Int. J. Sustain. High. Educ.* **2014**, *15*, 242–253. [CrossRef]
42. Watson, M.K.; Lozano, R.; Noyes, C.; Rodgers, M. Assessing curricula contribution to sustainability more holistically: Experiences from the integration of curricula assessment and students' perceptions at the Georgia Institute of Technology. *J. Clean. Prod.* **2013**, *61*, 106–116. [CrossRef]
43. Vasconcelos, C. Teaching environmental education through PBL: Evaluation of a teaching intervention program. *Res. Sci. Educ.* **2012**, *42*, 219–232. [CrossRef]
44. Yuriev, A.; Dahmen, M.; Paillé, P.; Boiral, O.; Guillaumie, L. Pro-environmental behaviors through the lens of the theory of planned behavior: A scoping review. *Resour. Conserv. Recycl.* **2020**, *155*, 104660. [CrossRef]
45. Gkargkavouzi, A.; Halkos, G.; Matsiori, S. Environmental behavior in a private-sphere context: Integrating theories of planned behavior and value belief norm, self-identity and habit. *Resour. Conserv. Recycl.* **2019**, *148*, 145–156. [CrossRef]

46. Kaaronen, R.O.; Strelkovskii, N. Cultural Evolution of Sustainable Behaviors: Pro-environmental Tipping Points in an Agent-Based Model. *One Earth* **2020**, *2*, 85–97. [\[CrossRef\]](#)
47. Clark, I.F.; Zeegers, Y. Challenging students' perceptions of sustainability using an Earth Systems Science approach. *J. Geogr. High. Educ.* **2015**, *39*, 260–274. [\[CrossRef\]](#)
48. Swaim, J.A.; Maloni, M.J.; Napshin, S.A.; Henley, A.B. Influences on student intention and behavior toward environmental sustainability. *J. Bus. Ethics* **2014**, *124*, 465–484. [\[CrossRef\]](#)
49. Wei, F.; Wang, S.; Fu, B.; Zhang, L.; Fu, C.; Kanga, E.M. Balancing community livelihoods and biodiversity conservation of protected areas in East Africa. *Curr. Opin. Environ. Sustain.* **2018**, *33*, 26–33. [\[CrossRef\]](#)
50. Steg, L. Promoting household energy conservation. *Energy Policy* **2008**, *36*, 4449–4453. [\[CrossRef\]](#)
51. Stevenson, F.; Leaman, A. Evaluating housing performance in relation to human behaviour: New challenges. *Build. Res. Inf.* **2010**, *38*, 437–441. [\[CrossRef\]](#)
52. Janda, K.B. Buildings don't use energy: People do. *Archit. Sci. Rev.* **2011**, *54*, 15–22. [\[CrossRef\]](#)
53. Gill, Z.M.; Tierney, M.J.; Pegg, I.M.; Allan, N. Low-energy dwellings: The contribution of behaviours to actual performance. *Build. Res. Inf.* **2010**, *38*, 491–508. [\[CrossRef\]](#)
54. Abrahamse, W.; Steg, L. How do socio-demographic and psychological factors relate to households' direct and indirect energy use and savings? *J. Econ. Psychol.* **2009**, *30*, 711–720. [\[CrossRef\]](#)
55. Gupta, R.; Barnfield, L. Unravelling the unintended consequences of home energy improvements. *Int. J. Energy Sect. Manag.* **2014**, *8*, 506–526. [\[CrossRef\]](#)
56. Yang, J.; Zou, P. *Households' Perceptions on Sustainable Home Behaviour and Improvements in Australia*; Coventry University: Coventry, UK, 2013; pp. 166–175.
57. Zou, P.; Yang, R. Improving sustainability of residential homes: Occupants motivation and behaviour. *Int. J. Energy Sect. Manag.* **2014**, *8*, 477–491. [\[CrossRef\]](#)
58. Canale, L.; Peulicke Slott, B.; Finsdóttir, S.; Kildemoes, L.R.; Andersen, R.K. Do in-home displays affect end-user consumptions? A mixed method analysis of electricity, heating and water use in Danish apartments. *Energy Build.* **2021**, *246*, 111094. [\[CrossRef\]](#)
59. Kikuchi-Uehara, E.; Nakatani, J.; Hirao, M. Analysis of factors influencing consumers' proenvironmental behavior based on life cycle thinking. Part I: Effect of environmental awareness and trust in environmental information on product choice. *J. Clean. Prod.* **2016**, *117*, 10–18. [\[CrossRef\]](#)
60. Sekhokoane, L.; Qie, N.; Rau, P.-L.P. Do consumption values and environmental awareness impact on green consumption in China? In Proceedings of the International Conference on Cross-Cultural Design, Vancouver, BC, Canada, 9–14 July 2017; pp. 713–723.
61. Yilmaz, V.; Can, Y. Impact of knowledge, concern and awareness about global warming and global climatic change on environmental behavior. *Environ. Dev. Sustain.* **2020**, *22*, 6245–6260. [\[CrossRef\]](#)
62. Wang, Y.; Sun, M.; Yang, X.; Yuan, X. Public awareness and willingness to pay for tackling smog pollution in China: A case study. *J. Clean. Prod.* **2016**, *112*, 1627–1634. [\[CrossRef\]](#)
63. Hadlock, T.D.; Beckwith, J.A. Recommendations to improve recovery of endangered species in the United States. *Hum. Dimens. Wildl.* **2002**, *7*, 37–53. [\[CrossRef\]](#)
64. Fu, L.; Sun, Z.; Zha, L.; Liu, F.; He, L.; Sun, X.; Jing, X. Environmental awareness and pro-environmental behavior within China's road freight transportation industry: Moderating role of perceived policy effectiveness. *J. Clean. Prod.* **2020**, *252*, 119796. [\[CrossRef\]](#)
65. Du Plessis, C.; Cole, R.J. Motivating change: Shifting the paradigm. *Build. Res. Inf.* **2011**, *39*, 436–449. [\[CrossRef\]](#)
66. Li, H.X.; Patel, D.; Al-Hussein, M.; Yu, H.; Gül, M. Stakeholder studies and the social networks of NetZero energy homes (NZEHS). *Sustain. Cities Soc.* **2018**, *38*, 9–17. [\[CrossRef\]](#)
67. Tokazhanov, G.; Tleuken, A.; Guney, M.; Turkyilmaz, A.; Karaca, F. How is COVID-19 experience transforming sustainability requirements of residential buildings? A review. *Sustainability* **2020**, *12*, 8732. [\[CrossRef\]](#)
68. Megahed, N.A.; Ghoneim, E.M. Antivirus-built environment: Lessons learned from COVID-19 pandemic. *Sustain. Cities Soc.* **2020**, *61*, 102350. [\[CrossRef\]](#)
69. Domínguez-Amarillo, S.; Fernández-Agüera, J.; Cesteros-García, S.; González-Lezcano, R.A. Bad air can also kill: Residential indoor air quality and pollutant exposure risk during the COVID-19 crisis. *Int. J. Environ. Res. Public Health* **2020**, *17*, 7183. [\[CrossRef\]](#)
70. Van Doremalen, N.; Bushmaker, T.; Morris, D.H.; Holbrook, M.G.; Gamble, A.; Williamson, B.N.; Tamin, A.; Harcourt, J.L.; Thornburg, N.J.; Gerber, S.I. Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *N. Engl. J. Med.* **2020**, *382*, 1564–1567. [\[CrossRef\]](#)
71. Mukherjee, A.; Babu, S.S.; Ghosh, S. Thinking about water and air to attain Sustainable Development Goals during times of COVID-19 Pandemic. *J. Earth Syst. Sci.* **2020**, *129*, 180. [\[CrossRef\]](#)
72. Pemmada, R.; Zhu, X.; Dash, M.; Zhou, Y.; Ramakrishna, S.; Peng, X.; Thomas, V.; Jain, S.; Nanda, H.S. Science-based strategies of antiviral coatings with viricidal properties for the COVID-19 like pandemics. *Materials* **2020**, *13*, 4041. [\[CrossRef\]](#) [\[PubMed\]](#)
73. Lytle, C.D.; Sagripanti, J.-L. Predicted inactivation of viruses of relevance to biodefense by solar radiation. *J. Virol.* **2005**, *79*, 14244–14252. [\[CrossRef\]](#) [\[PubMed\]](#)

74. Alonso-Sáez, L.; Gasol, J.M.; Lefort, T.; Hofer, J.; Sommaruga, R. Effect of natural sunlight on bacterial activity and differential sensitivity of natural bacterioplankton groups in northwestern Mediterranean coastal waters. *Appl. Environ. Microbiol.* **2006**, *72*, 5806–5813. [CrossRef] [PubMed]
75. Clements, N.; Binnicker, M.J.; Roger, V.L. Indoor environment and viral infections. *Mayo Clin. Proc.* **2020**, *95*, 1581–1583. [CrossRef]
76. Karaca, F.; Guney, M.; Kumisbek, A. Indicator rating methodology for Rapid Sustainability Assessment Method (RSAM) for existing residential buildings using opinions of residents. *MethodsX* **2020**, *7*, 101105. [CrossRef]
77. Liu, J.; Zhou, J.; Yao, J.; Zhang, X.; Li, L.; Xu, X.; He, X.; Wang, B.; Fu, S.; Niu, T. Impact of meteorological factors on the COVID-19 transmission: A multi-city study in China. *Sci. Total Environ.* **2020**, *726*, 138513. [CrossRef]
78. Cuervo-Vilches, T.; Navas-Martín, M.Á.; Oteiza, I. A mixed approach on resilience of Spanish dwellings and households during COVID-19 lockdown. *Sustainability* **2020**, *12*, 10198. [CrossRef]
79. Maas, J.; Verheij, R.A.; de Vries, S.; Spreeuwenberg, P.; Schellevis, F.G.; Groenewegen, P.P. Morbidity is related to a green living environment. *J. Epidemiol. Community Health* **2009**, *63*, 967–973. [CrossRef]
80. Brief, P. COVID-19 and the Need for Action on Mental Health; World Health Organization: Geneva, Switzerland, 2020.
81. Amerio, A.; Brambilla, A.; Morganti, A.; Aguglia, A.; Bianchi, D.; Santi, F.; Costantini, L.; Odone, A.; Costanza, A.; Signorelli, C. COVID-19 lockdown: Housing built environment's effects on mental health. *Int. J. Environ. Res. Public Health* **2020**, *17*, 5973. [CrossRef]
82. Settimo, G. Residential indoor air quality: Significant parameters in light of the new trends. *Ig. Sanità Pubblica* **2012**, *68*, 136–138.
83. Holmgren, M.; Kabanshi, A.; Sörqvist, P. Occupant perception of “green” buildings: Distinguishing physical and psychological factors. *Build. Environ.* **2017**, *114*, 140–147. [CrossRef]
84. UNICEF. Water, Sanitation, Hygiene, and Waste Management for the COVID-19 Virus: Interim Guidance. 2020. Available online: https://apps.who.int/iris/bitstream/handle/10665/333560/WHO-2019-nCoV-IPC_WASH-2020.4-chi.pdf (accessed on 22 September 2020).
85. La Rosa, G.; Iaconelli, M.; Mancini, P.; Ferraro, G.B.; Veneri, C.; Bonadonna, L.; Lucentini, L.; Suffredini, E. First detection of SARS-CoV-2 in untreated wastewaters in Italy. *Sci. Total Environ.* **2020**, *736*, 139652. [CrossRef] [PubMed]
86. La Rosa, G.; Bonadonna, L.; Lucentini, L.; Kenmoe, S.; Suffredini, E. Coronavirus in water environments: Occurrence, persistence and concentration methods-A scoping review. *Water Res.* **2020**, *179*, 115899. [CrossRef] [PubMed]
87. Zambrano-Monserrate, M.A.; Ruano, M.A.; Sanchez-Alcalde, L. Indirect effects of COVID-19 on the environment. *Sci. Total Environ.* **2020**, *728*, 138813. [CrossRef]
88. Rume, T.; Islam, S.D.-U. Environmental effects of COVID-19 pandemic and potential strategies of sustainability. *Heliyon* **2020**, *6*, e04965. [CrossRef] [PubMed]
89. Capasso, L.; Gaeta, M.; Appolloni, L.; D'alessandro, D. Health inequalities and inadequate housing: The case of exceptions to hygienic requirements for dwellings in Italy. *Ann. Ig.* **2017**, *29*, 323–331.
90. Frontczak, M.; Schiavon, S.; Goins, J.; Arens, E.; Zhang, H.; Wargocki, P. Quantitative relationships between occupant satisfaction and satisfaction aspects of indoor environmental quality and building design. *Indoor Air* **2012**, *22*, 119–131. [CrossRef]
91. Blay-Palmer, A.; Carey, R.; Valette, E.; Sanderson, M.R. Post COVID 19 and food pathways to sustainable transformation. *Agric. Hum. Values* **2020**, *37*, 517–519. [CrossRef]
92. Soga, M.; Gaston, K.J.; Yamaura, Y. Gardening is beneficial for health: A meta-analysis. *Prev. Med. Rep.* **2017**, *5*, 92–99. [CrossRef]
93. Tokazhanov, G.; Tleuken, A.; Durdyev, S.; Otesh, N.; Guney, M.; Turkyilmaz, A.; Karaca, F. Stakeholder based weights of new sustainability indicators providing pandemic resilience for residential buildings. *Sustain. Cities Soc.* **2021**, *75*, 103300. [CrossRef] [PubMed]
94. Fatourehchi, D.; Zarghami, E. Social sustainability assessment framework for managing sustainable construction in residential buildings. *J. Build. Eng.* **2020**, *32*, 101761. [CrossRef]
95. Wan, L.; Ng, E. Evaluation of the social dimension of sustainability in the built environment in poor rural areas of China. *Archit. Sci. Rev.* **2018**, *61*, 319–326. [CrossRef]
96. Ahmad, T.; Thaheem, M.J. Developing a residential building-related social sustainability assessment framework and its implications for BIM. *Sustain. Cities Soc.* **2017**, *28*, 1–15. [CrossRef]
97. Ullah, W.; Noor, S.; Tariq, A. The development of a basic framework for the sustainability of residential buildings in Pakistan. *Sustain. Cities Soc.* **2018**, *40*, 365–371. [CrossRef]
98. Maleki, B.; Rubio, M.d.M.C.; Hosseini, S.M.A.; De La Fuente Antequera, A. Multi-criteria decision making in the social sustainability assessment of high-rise residential buildings. *IOP Conf. Ser. Earth Environ. Sci.* **2019**, *290*, 012054. [CrossRef]
99. Karji, A.; Woldesenbet, A.; Khanzadi, M.; Tafazzoli, M. Assessment of Social Sustainability Indicators in Mass Housing Construction: A Case Study of Mehr Housing Project. *Sustain. Cities Soc.* **2019**, *50*, 101697. [CrossRef]
100. Shan, M.; Hwang, B.-G. Green building rating systems: Global reviews of practices and research efforts. *Sustain. Cities Soc.* **2018**, *39*, 172–180. [CrossRef]
101. Akhanova, G.; Nadeem, A.; Kim, J.R.; Azhar, S. A multi-criteria decision-making framework for building sustainability assessment in Kazakhstan. *Sustain. Cities Soc.* **2020**, *52*, 101842. [CrossRef]
102. Alyami, S.H.; Rezgui, Y.; Kwan, A. Developing sustainable building assessment scheme for Saudi Arabia: Delphi consultation approach. *Renew. Sustain. Energy Rev.* **2013**, *27*, 43–54. [CrossRef]

103. Tokbolat, S.; Karaca, F.; Durdyev, S.; Nazipov, F.; Aidynkaliyev, I. Assessment of green practices in residential buildings: A survey-based empirical study of residents in Kazakhstan. *Sustainability* **2018**, *10*, 4383. [CrossRef]
104. Kamali, M.; Hewage, K.N. Performance indicators for sustainability assessment of buildings. In Proceedings of the International Construction Specialty Conference of the Canadian Society for Civil Engineering (ICSC), Vancouver, BC, Canada, 7–10 June 2015; pp. 8–10.
105. Kilnarová, P.; Wittmann, M. Open Space between Residential Buildings as a Factor of Sustainable Development—Case Studies in Brno (Czech Republic) and Vienna (Austria). *IOP Conf. Ser. Earth Environ. Sci.* **2017**, *95*, 052008. [CrossRef]
106. Winston, N. Regeneration for sustainable communities? Barriers to implementing sustainable housing in urban areas. *Sustain. Dev.* **2010**, *18*, 319–330. [CrossRef]
107. Zavrl, M.; Žarnić, R.; Šelih, J. Multicriterial sustainability assessment of residential buildings. *Technol. Econ. Dev. Econ.* **2009**, *15*, 612–630. [CrossRef]
108. Mateus, R.; Bragança, L. Sustainability assessment and rating of buildings: Developing the methodology SBToolPT-H. *Build. Environ.* **2011**, *46*, 1962–1971. [CrossRef]
109. Yadegaridehkordi, E.; Hourmand, M.; Nilashi, M.; Alsolami, E.; Samad, S.; Mahmoud, M.; Alarood, A.A.; Zainol, A.; Majeed, H.D.; Shuib, L. Assessment of sustainability indicators for green building manufacturing using fuzzy multi-criteria decision making approach. *J. Clean. Prod.* **2020**, *277*, 122905. [CrossRef]
110. Al-Jebouri, M.F.A.; Saleh, M.S.; Raman, S.N.; Rahmat, R.A.A.B.O.K.; Shaaban, A.K. Toward a national sustainable building assessment system in Oman: Assessment categories and their performance indicators. *Sustain. Cities Soc.* **2017**, *31*, 122–135. [CrossRef]
111. Chandratilake, S.R.; Dias, W.P.S. Sustainability rating systems for buildings: Comparisons and correlations. *Energy* **2013**, *59*, 22–28. [CrossRef]
112. Chandratilake, S.R.; Dias, W.P.S. Ratio based indicators and continuous score functions for better assessment of building sustainability. *Energy* **2015**, *83*, 137–143. [CrossRef]
113. Gou, Z.; Lau, S.S.-Y. Contextualizing green building rating systems: Case study of Hong Kong. *Habitat Int.* **2014**, *44*, 282–289. [CrossRef]
114. Markelj, J.; Kitek Kuzman, M.; Grošelj, P.; Zbašnik-Senegačnik, M. A Simplified Method for Evaluating Building Sustainability in the Early Design Phase for Architects. *Sustainability* **2014**, *6*, 8775. [CrossRef]
115. Raut, R.; Kamble, S.; Jha, M. An assessment of sustainable house using FST-QFD-AHP multi-criteria decision-making approach. *Int. J. Procure. Manag.* **2016**, *9*, 86–122. [CrossRef]
116. Janjua, S.Y.; Sarker, P.K.; Biswas, W.K. Development of triple bottom line indicators for life cycle sustainability assessment of residential bulidings. *J. Environ. Manag.* **2020**, *264*, 110476. [CrossRef] [PubMed]
117. Kamali, M.; Hewage, K.; Milani, A.S. Life cycle sustainability performance assessment framework for residential modular buildings: Aggregated sustainability indices. *Build. Environ.* **2018**, *138*, 21–41. [CrossRef]
118. Taecharungroj, V.; Suksaroj, T.T.; Rattanapan, C. The place sustainability scale: Measuring residents' perceptions of the sustainability of a town. *J. Place Manag. Dev.* **2018**, *11*, 370–390. [CrossRef]
119. Vučićević, B.; Stojiljković, M.; Afgan, N.; Turanjanin, V.; Jovanović, M.; Bakić, V. Sustainability assessment of residential buildings by non-linear normalization procedure. *Energy Build.* **2013**, *58*, 348–354. [CrossRef]
120. Amasuomo, T.T.; Atanda, J.; Baird, G. Development of a Building Performance Assessment and Design Tool for Residential Buildings in Nigeria. *Procedia Eng.* **2017**, *180*, 221–230. [CrossRef]
121. Mushtaha, E.; Shamsuzzaman, M.; Abdouli, S.A.; Hamdan, S.; Soares, T.G. Application of the analytic hierarchy process to developing sustainability criteria and assessing heritage and modern buildings in the UAE. *Archit. Eng. Des. Manag.* **2020**, *16*, 329–355. [CrossRef]
122. Baird, G. Users' perceptions of sustainable buildings—Key findings of recent studies. *Renew. Energy* **2015**, *73*, 77–83. [CrossRef]
123. SCOPUS. Sustainability and Sustainable Development in the UAE. 2022. Available online: <https://www.scopus.com/term/analyzer.uri?sid=c1d631665bba56f67d6ff50464180401&origin=resultslist&src=s&s=TITLE-ABS-KEY%28%22sustainability%22+or+%22+sustainable+development%22+and+%22UAE%22%29&sort=plf-f&sdt=b&sot=b&sl=71&count=604&analyzeResults=Analyze+results&txGid=fecb556b0c8b488ae292fd21a7d03490> (accessed on 22 September 2020).
124. Iwaro, J.; Mwasha, A.; Williams, R.G.; Wilson, W. An integrated approach for sustainable design and assessment of residential building envelope: Part II. *Int. J. Low-Carbon Technol.* **2016**, *11*, 89–108. [CrossRef]
125. Zarghami, E.; Fatourehchi, D.; Karamloo, M. Establishing a region-based rating system for multi-family residential buildings in Iran: A holistic approach to sustainability. *Sustain. Cities Soc.* **2019**, *50*, 101631. [CrossRef]
126. Mwasha, A.; Williams, R.G.; Iwaro, J. Modeling the performance of residential building envelope: The role of sustainable energy performance indicators. *Energy Build.* **2011**, *43*, 2108–2117. [CrossRef]
127. Ali, H.H.; Al Nsairat, S.F. Developing a green building assessment tool for developing countries—Case of Jordan. *Build. Environ.* **2009**, *44*, 1053–1064. [CrossRef]
128. Gerhard, T. Bias: Considerations for research practice. *Am. J. Health-Syst. Pharm.* **2008**, *65*, 2159–2168. [CrossRef] [PubMed]
129. Almeida, C.P.B.d.; Goulart, B.N.G.d. How to avoid bias in systematic reviews of observational studies. *Rev. CEFAC* **2017**, *19*, 551–555. [CrossRef]

130. Suhr, D.D. Exploratory or confirmatory factor analysis? In Proceedings of the 31st Annual SAS? Users Group International Conference, San Francisco, CA, USA, 26–29 March 2006.
131. DiStefano, C.; Hess, B. Using confirmatory factor analysis for construct validation: An empirical review. *J. Psychoeduc. Assess.* **2005**, *23*, 225–241. [\[CrossRef\]](#)
132. Geldhof, G.J.; Preacher, K.J.; Zyphur, M.J. Reliability estimation in a multilevel confirmatory factor analysis framework. *Psychol. Methods* **2014**, *19*, 72. [\[CrossRef\]](#)
133. Bowen, N.K.; Guo, S. *Structural Equation Modeling*; Oxford University Press: Oxford, UK, 2011.
134. Van de Vijver, F. Capturing bias in structural equation modeling. In *Cross-Cultural Analysis: Methods and Applications*; Davidov, E., Schmidt, P., Billiet, J., Eds.; Routledge: London, UK, 2011; pp. 3–34.
135. Worthy, L.D.; Lavigne, T.; Romero, F. Procedural Bias. *Cult. Psychol.* **2020**.
136. Jackson, L.; Ervin, K.; Gardner, P. Gender and the internet: Women communicating and men searching. *Sex Roles* **2001**, *44*, 363–379. [\[CrossRef\]](#)
137. Smith, G. *Does Gender Influence Online Survey Participation?: A Record-Linkage Analysis of University Faculty Online Survey Response Behavior*; ERIC Document Reproduction Service No. ED 501717; ERIC: Kansas City, MO, USA, 2008.
138. Hofer, E. On surveys of expert opinion. *Nucl. Eng. Des.* **1986**, *93*, 153–160. [\[CrossRef\]](#)
139. Ball, H.L. Conducting online surveys. *J. Hum. Lact.* **2019**, *35*, 413–417. [\[CrossRef\]](#) [\[PubMed\]](#)
140. Sharma, S. *Applied Multivariate Techniques*; John Wiley and Sons Inc.: New York, NY, USA, 1996.
141. Peterson, R.A.; Kim, Y. On the relationship between coefficient alpha and composite reliability. *J. Appl. Psychol.* **2013**, *98*, 194. [\[CrossRef\]](#) [\[PubMed\]](#)
142. Ullman, J.B.; Bentler, P.M. Structural equation modeling. In *Handbook of Psychology*, 2nd ed.; John Wiley and Sons Inc.: New York, NY, USA, 2012.
143. Weston, R.; Gore, P.A., Jr. A brief guide to structural equation modeling. *Couns. Psychol.* **2006**, *34*, 719–751. [\[CrossRef\]](#)
144. Hoyle, R.H. *The Structural Equation Modeling Approach: Basic Concepts and Fundamental Issues*; APA: Washington, DC, USA, 1995.
145. Hox, J.J.; Bechger, T.M. An introduction to structural equation modeling. *Fam. Sci. Rev.* **1998**, *11*, 354–373.
146. Chankrajang, T.; Muttarak, R. Green returns to education: Does schooling contribute to pro-environmental behaviours? Evidence from Thailand. *Ecol. Econ.* **2017**, *131*, 434–448. [\[CrossRef\]](#)
147. UAE and the 2030 Agenda for Sustainable Development—Excellence in Implementation—2018. 2018. Available online: <https://fcsa.gov.ae/en-us/Documents/SDG%20Report%20EN%20Final.pdf> (accessed on 22 April 2022).
148. Alameeri, A.; Ajmal, M.M.; Hussain, M.; Helo, P. Sustainable management practices in UAE hotels. *Int. J. Cult. Tour. Hosp. Res.* **2018**, *12*, 440–466. [\[CrossRef\]](#)
149. Yue, S.; Lu, R.; Chen, H.; Yuan, J. Does financial development promote the win-win balance between environmental protection and economic growth? *Environ. Sci. Pollut. Res.* **2018**, *25*, 36438–36448. [\[CrossRef\]](#)
150. Fonseca, L.M.; Domingues, J.P.; Dima, A.M. Mapping the Sustainable Development Goals Relationships. *Sustainability* **2020**, *12*, 3359. [\[CrossRef\]](#)
151. Apresian, S.R.; Tyson, A.; Varkkey, H.; Choiruzzad, S.A.B.; Indraswari, R. Palm oil development in Riau, Indonesia: Balancing economic growth and environmental protection. *Nusantara* **2020**, *2*, 1–29.
152. Sharma, H.; Kumar, S. A survey on decision tree algorithms of classification in data mining. *Int. J. Sci. Res. (IJSR)* **2016**, *5*, 2094–2097.
153. Friedl, M.A.; Brodley, C.E. Decision tree classification of land cover from remotely sensed data. *Remote Sens. Environ.* **1997**, *61*, 399–409. [\[CrossRef\]](#)
154. Podgorelec, V.; Kokol, P.; Stiglic, B.; Rozman, I. Decision Trees: An Overview and Their Use in Medicine. *J. Med. Syst.* **2002**, *26*, 445–463. [\[CrossRef\]](#) [\[PubMed\]](#)
155. Kingsford, C.; Salzberg, S.L. What are decision trees? *Nat. Biotechnol.* **2008**, *26*, 1011–1013. [\[CrossRef\]](#) [\[PubMed\]](#)
156. Blasco, N.; Brusca, I.; Labrador, M. Assessing sustainability and its performance implications: An empirical analysis in Spanish public universities. *Sustainability* **2019**, *11*, 5302. [\[CrossRef\]](#)
157. Sulewski, P.; Kłoczko-Gajewska, A.; Sroka, W. Relations between agri-environmental, economic and social dimensions of farms' sustainability. *Sustainability* **2018**, *10*, 4629. [\[CrossRef\]](#)
158. Whang, S.-W.; Kim, S. Balanced sustainable implementation in the construction industry: The perspective of Korean contractors. *Energy Build.* **2015**, *96*, 76–85. [\[CrossRef\]](#)
159. Vasylieva, T.; Lyulyov, O.; Bilan, Y.; Streimikiene, D. Sustainable economic development and greenhouse gas emissions: The dynamic impact of renewable energy consumption, GDP, and corruption. *Energies* **2019**, *12*, 3289. [\[CrossRef\]](#)
160. Lozano, R.; Barreiro-Gen, M.; Lozano, F.J.; Sammalisto, K. Teaching sustainability in European higher education institutions: Assessing the connections between competences and pedagogical approaches. *Sustainability* **2019**, *11*, 1602. [\[CrossRef\]](#)
161. Zwickle, A.; Koontz, T.M.; Slagle, K.M.; Bruskotter, J.T. Assessing sustainability knowledge of a student population: Developing a tool to measure knowledge in the environmental, economic and social domains. *Int. J. Sustain. High. Educ.* **2014**, *15*, 375–389. [\[CrossRef\]](#)
162. Anderson, A. Media, politics and climate change: Towards a new research agenda. *Sociol. Compass* **2009**, *3*, 166–182. [\[CrossRef\]](#)
163. Wee, Y.S.; Quazi, H.A. Development and validation of critical factors of environmental management. *Ind. Manag. Data Syst.* **2005**, *105*, 96–114.

164. Azapagic, A.; Perdan, S.; Shallcross, D. How much do engineering students know about sustainable development? The findings of an international survey and possible implications for the engineering curriculum. *Eur. J. Eng. Educ.* **2005**, *30*, 1–19. [[CrossRef](#)]
165. Watson, M.K.; Noyes, C.; Rodgers, M.O. Student perceptions of sustainability education in civil and environmental engineering at the Georgia Institute of Technology. *J. Prof. Issues Eng. Educ. Pract.* **2013**, *139*, 235–243. [[CrossRef](#)]
166. Glass, C.; Cook, A.; Ingersoll, A.R. Do women leaders promote sustainability? Analyzing the effect of corporate governance composition on environmental performance. *Bus. Strategy Environ.* **2016**, *25*, 495–511. [[CrossRef](#)]
167. Kassinis, G.; Panayiotou, A.; Dimou, A.; Katsifarakis, G. Gender and environmental sustainability: A longitudinal analysis. *Corp. Soc. Responsib. Environ. Manag.* **2016**, *23*, 399–412. [[CrossRef](#)]
168. Leiserowitz, A.A.; Kates, R.W.; Parris, T.M. Do global attitudes and behaviors support sustainable development? *Environ. Sci. Policy Sustain. Dev.* **2005**, *47*, 22–38. [[CrossRef](#)]
169. Bloodhart, B.; Swim, J.K. Sustainability and consumption: What's gender got to do with it. *J. Soc. Issues* **2020**, *76*, 101–113. [[CrossRef](#)]
170. Harlan, S.L.; Yabiku, S.T.; Larsen, L.; Brazel, A.J. Household water consumption in an arid city: Affluence, affordance, and attitudes. *Soc. Nat. Resour.* **2009**, *22*, 691–709. [[CrossRef](#)]