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A Framework of Building Sustainability Assessment System for the Commercial Buildings in Kazakhstan

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Abstract: Many building assessment tools exist for guiding building facilities toward sustainability. Some tools are internationally recognized while others are for specific countries based on local needs. This study endeavored to develop a building sustainability assessment framework for Kazakhstan. The framework was developed based on the review of building performance assessment methods such as leadership in energy and environmental design (LEED), building research establishment environmental assessment methodology (BREEAM), comprehensive assessment system for building environmental efficiency (CASBEE), and international initiative for sustainable built environment (SBTool), and considering the local conditions in Kazakhstan. A two-round Delphi survey was employed to develop the assessment categories and indicators by local experts from the architecture, engineering, and construction industry. Mean and standard deviation values were used to analyze the survey data and to make the decision on the level of agreement amongst the Delphi panelists. The proposed framework consists of nine assessment categories, 46 assessment indicators, and 142 parameters covering the four climatic regions in Kazakhstan and considering the environmental, social, and economic perspectives of the country's sustainable development goals. The introduction of the framework is expected to serve as a reference for establishing the regional building sustainability assessment tool that will aid to increase the awareness of the public and help policymakers to solve sustainability-related issues in Kazakhstan.

Keywords: sustainability; sustainable construction; building sustainable assessment framework; Kazakhstan

1. Introduction

1.1. Background

The concept of sustainability has gained broad recognition in the construction industry due to the adverse impact of construction activities on the natural environment. As reported by the United Nations Environment Program, the construction industry is responsible for one-third of CO_2 emissions, 30% of greenhouse gas emissions, and 25% of the waste production annually [1]. Buildings account for up to 40% the of total energy use, whereas building construction consumes considerable amount of natural resources, which are about 70% of cement products and 25% of steel and virgin wood [1–3]. Due to these concerns, application of sustainable development practices within the construction industry has gained a lot of attention and has resulted in the evolution of international policies and declarations to preserve the environment and promote the benefits of assessment systems to improve sustainability [4]. Building sustainability assessment systems assist in incorporating sustainability into construction activities. Assessment tools serve as reference methods for building practitioners to promote building sustainability by setting design priorities and goals, and by quantifying the environmental performance.

In addition, assessment tools can be used to evaluate performance measures and collect information that guides the sustainable design and help decision-making processes [5–7]. Assessment tools attempt to: (1) Improve buildings' functional performance; (2) decrease environmental burden; (3) estimate buildings' environmental influence; and (4) objectively assess and evaluate buildings' development [8].

Numerous research results show that using the building assessment system in the design and build process can provide considerable benefits that cannot be achieved through conventional practices. Assessment systems help to create healthier facilities for users and occupants by improving the indoor environment quality and attract residents by decreasing energy and water consumption costs of the building during its whole lifecycle. Also, these tools encourage the use of low volatile and organic materials for occupants' easier breathing and healthier feeling; thus, improving the air and increasing the long- term occupant health in green-certified buildings [9]. Other benefits of building certification include energy and water savings, fewer greenhouse gas emissions compared to conventional buildings, and less energy and water consumption on average [10].

1.2. Existing Building Sustainability Assessment Systems

The first generation of assessment tools originated in developed countries, including BREEAM (building research establishment environmental assessment methodology) in UK, LEED (leadership in energy and environmental design) in the US, CASBEE (comprehensive assessment system for building environmental efficiency) in Japan, and SBTool (international initiative for sustainable built environment) in Canada. These tools have rapidly gained world recognition and several other countries started to adopt them [11–13]. However, it should be noted that these tools and rating systems were developed for evaluating sustainable buildings in particular regions based on the local sustainability requirements [14]. Hence, because of the variations in geography, climate, cultural perceptions, and potential natural resources availability, one system established for a specific region may not be suitable for adoption in another region [15–17].

Therefore, other countries started the development of regional or national assessment tools specific to their local context. For instance, Ali and Nsairat [18] developed an assessment tool for the environmental, social, and economic conditions of Jordan. Through studying the performance evaluation methods such as BREEAM, LEED, CASBEE, and SBTool, they defined new assessment items related to the context of Jordan and discussed these items with different stakeholders and sustainable development experts. Similar research has been conducted by Vyas and Jha [19] to design an assessment tool for India. Zarghami et al. [9] customized reputable sustainability assessment tools such as BREEAM, LEED, CASBEE, and SBTool to develop an Iranian sustainability assessment method for residential buildings. The research developed a methodology that considers the critical sustainability aspects and practices in Iran. After a thorough investigation of existing assessment methods with a view of adapting them for Nigerian conditions, Amasuomo et al. [20] proposed the comprehensive performance assessment system for Nigeria (CPASN) consisting of three main steps as a level of sustainability, the indicators, and the outcome. Other research has been conducted by Shad et al. [21] with an aim of developing green building assessment tool in Iran for an office building with five certification levels established to enhance environmental, social, and economic aspects of the construction activities. Banani et al. [17] compared five environmental rating tools like BREEAM, LEED, Green Star, CASBEE, and Estidama and proposed a sustainable criteria framework with nine main criteria and 36 sub-criteria for Saudi Arabian non-residential buildings.

1.3. Need for Green Standards in Kazakhstan

Just like other developing countries, Kazakhstan needs a building sustainability assessment system. Due to the variations in standard practices, cultures, social, economic, and environmental considerations, other well-known international assessment systems such as LEED and BREEAM may not work well for Kazakhstan in their original form. For instance, heat pumps are used in some countries, whereas in Kazakhstan, independent boiling units are used due to the supply of cheap energy.

Moreover, the use of foreign building sustainability assessment systems in Kazakhstan may be quite costly for an average Kazakhstani building developer. For example, the average LEED certification expenses for a building with 10,000 to 50,000 m^2 are about US$100,000 or more, whereas BREEAM certification costs are around US$70,000 with an additional 15–20% of this cost going to consultants who guide the project implementation [22]. In response to these challenges, new driving forces are appearing for green technologies. Kazakhstan Green Building Council (KazGBC) was founded in 2014. In 2015, it became a member of World Green Building Council. In 2017, KazGBC started designing the first national certification system in Kazakhstan for residential buildings [23].

To date, green and sustainable building principles have been mostly applied to residential buildings in Kazakhstan [23–25]. As of today, no published research exists on developing sustainability assessment tools for non-residential or commercial buildings in Kazakhstan. Thus, there is a need to develop sustainable building assessment framework for non-residential buildings in Kazakhstan. The aim of this research is to develop a building sustainability assessment framework for commercial buildings in Kazakhstan with the approach to adapt pertinent indicators and assessment items of selected well-recognized international assessment systems. Therefore, this research has the following objectives:

1. To establish the sustainability issues of commercial buildings in Kazakhstan.
2. To study the pertinent indicators of internationally recognized sustainability assessment systems to choose/define new assessment items in order to develop the framework of building sustainability assessment system for commercial buildings in Kazakhstan.

The developed framework should match the Kazakhstan context and should be addressed towards the new commercial buildings. Other types of buildings were not in the scope of this research. The proposed framework should be implemented from the preliminary design stages and consider building life cycle. This framework will serve as a reference for developing National/Regional Non-residential (commercial buildings in particular) building sustainability assessment system, and guide policymakers and designers to construct and operate sustainable buildings in Kazakhstan.

2. Literature Review

2.1. Overview of Kazakhstan

The construction industry in Kazakhstan is a significant economic sector with substantial influence on other sectors of the economy. The value of the construction industry to GDP averages to almost 6.5% between 2010 and 2015 [26]. Thereby, the sustainability of the building sector is critical for the environmental and economic development and social welfare of the country.

The energy sector in Kazakhstan produces 80% of total emissions; 90% of which is produced by power and heat generation. The building industry is the third largest energy user after the energy and manufacturing industries and one of the leading greenhouse gas (GHG) emitters in the country. According to the United Nations Development Program [27], buildings account for 13.5% power and 24% heat demand in Kazakhstan. Further, the air pollution from the thermal energy sector's inefficiency, non-ferrous metallurgy, solid waste (97% of waste is discharged without treatment), and greenhouse gas emissions are substantially higher than neighboring countries with similar levels of GDP [28].

2.2. Climate of Kazakhstan

Kazakhstan has a range of geographic features with continental climate. The climate condition in Kazakhstan is arid and the country is almost entirely covered by steppes and deserts with average annual precipitation exceeding 300 mm in the northern area, 150–200 mm in the central and southern parts, and even to around 100 mm in the area of the Aral Sea [29]. Central Asia becomes very cold in winter and extremely hot in summer due to the huge distance from the oceans; thus, both highest and coldest records can be observed. The average temperature in Kazakhstan is between −4 °C and −19 °C in winter and between +19 and +26 °C in summer. In winter, the temperature may decrease down to −45 °C and in summer can rise up to 45 °C [30].

According to the Building Climatology of Kazakhstan, climatic zones for construction are classified into four zones (with 16 subzones). These zones are the territories with common typological requirements for buildings and facilities (such as building type and orientation, architectural and planning solutions, etc.). *The first climatic zone* includes zones with an average temperature less than −14 °C in January, with the short light year and long-lasting heating period, requiring good thermal protection, and need for protecting the buildings and facilities from strong winds. The *second climatic zone* considers the zones with an average temperature in January between −14 and −3 °C, with long-lasting and moderate temperatures in winter, requiring the need for heat protection of buildings. The *third climatic zone* is characterized by an average monthly temperature in January between −20 and −2 °C, with higher solar radiation intensity, and negative air temperature during winter and hot summer, which defines the necessity of building heat protection in winter and excessive heat protection during the warm periods. *The fourth climatic zone* is a climatic region with average monthly temperature in January between −15 °C and 6 °C, with a hot summer and intensive solar radiation, and a relatively short winter with moderate lasting heating period, with the necessity of building heat protection in winter and excessive heat protection needed during the warm periods [30].

As a result of the severe continental climate, heating is one of the basic needs of living in Kazakhstan. In most of its regions, the heating season is more than half-a-year long and varies from 143 to 231 days [30]. Therefore, energy audit and certification of buildings are mandatory for new and existing buildings in Kazakhstan. Energy certification of buildings is one of the core measures to monitor and reduce energy consumption, and for these purposes, the method of climatic zoning is applied. Climatic zoning considers the climatic data such as temperature and length of the heating period, heating degree days, and average value of horizontal solar radiation during the heating season [30]. These data are used to design the building thermal protection and thermal loading.

Therefore, an assessment framework will be developed according to these four climatic zones based on regional and local priority in terms of the renewable resources' availability, geographic and climatic considerations, the duration of the winter and summer, and average temperature variations. For instance, in climatic zones 3 and 4, it is extremely hot during the summer time, with a relatively short warm winter. Thus, in these regions, there is a huge potential for solar energy use through photovoltaic panels. In addition to warm regions, people spend more time outdoors than indoors. Meanwhile, in climatic zones 1 and 2, there is sufficient availability of wind to use wind energy as a renewable resource. Moreover, in zone 1, there are regions with long winters, where people spend more time indoors than outdoors; thus, in these regions, indoor environmental quality with proper ventilation, daylighting, thermal, and acoustic comfort has to be taken into consideration. These particular climatic conditions have considerable impact on building life-span. Therefore, in the pre-design phase of the building, life-cycle climatic conditions play an important role in predicting the building life-span. Particularly, in the climatic zones with severe winters and extremely hot summers, temperature-humidity conditions, length of heating days, freezing, and thawing are the main parameters to calculate and predict the life-expectancy of the facility.

2.3. Energy Situation in Kazakhstan

The role of energy is huge in the maintenance of a country's social and economic growth because of the highly energy-demanding economy in Kazakhstan. Kazakhstan's energy resources comprise of coal, oil, natural gas, hydro, and renewable energy. Coal dominates the energy sector in Kazakhstan, and as a result, the country is the largest greenhouse gas (GHG) emitter in Central Asia with annual emissions of 284 Mt CO_2 in 2012 [31]. The main causes of the high emissions are the use of outdated technologies and the lack of effective incentives for energy conservation. Substituting fossil fuels that are depleting and contributing largely to the world energy use with alternative sources is necessary. Kazakhstan has significant potential for renewable energy, but the contribution of alternative sources in power production is only 0.6%. Kazakhstan is among the top 15 countries with proven oil reserves of about 3.9 billion tones and natural gas reserves of about 1.3 trillion m^3 [32]. It is predicted that due to the country's development, the energy use in buildings increases. Subsequently, the use of alternative resources is inevitable in the near future [33]. Kazakhstan can benefit from wind and solar energy with vast windy regions and sunlight hours per year (2200–3000 h) [34]. Accordingly, considering Kazakhstan's green energies potential, the country should consider implementing the sustainable development practices to promote green resources.

2.4. Sustainable Development Goals of Kazakhstan

Kazakhstan is spearheading a number of nation-wide initiatives to transfer the nation into an eco-friendly economy. The country is committed to becoming one of the top 30 of the world's 50 developing nations by 2050, and a "greening" of critical economic sectors is part of this economic drive. As an oil-producing nation, moving from 'brown' to green will be a challenge [33].

In September 2015, the President of Kazakhstan signed a new document that points out the goals and targets of sustainable development of Kazakhstan. These sustainable development goals are a comprehensive set of goals and targets until 2030 aimed at improving the quality of life of citizens, socio-economic development, and environmental sustainability of states [35]. The sustainable development goals of Kazakhstan include 17 objectives to be achieved by 2030 and are called upon to contribute to the achievement of sustainable development through the integration of economic, social, and environmental components. These goals are elimination of poverty in all its forms, provide a healthy lifestyle and promote wellbeing for all, ensure rational use of water resources, provide access to sustainable and modern energy sources, promote sustainable economic growth, create stable and sustainable infrastructure, ensure vitality and environmental sustainability in cities and settlements, ensure transition to rational consumption and production, and measures to combat climate change and its consequences [35].

The building industry plays a major role in achieving Kazakhstan's green ambitions, since the building sector is one area of high energy use in Kazakhstan. Buildings utilize 13.5% of the nation's electric power and 24% of the heat supply [27]. Therefore, the building sector can significantly contribute to the achievement of sustainable development goals set by Kazakh government through energy efficient buildings, low-carbon design strategies, efficient resource consumption, and adequate construction waste management. Formation of the Kazakhstan Green Building Council (KazGBC) was another step in achieving the sustainable development goals in Kazakhstan. Another remarkable event towards the country's shift to green buildings was to host Expo 2017 with the theme "Future Energy". The aims of this event were to accelerate the number of eco-projects after the event and to raise education and awareness among population.

2.5. Country's Environmental, Social, and Economic Perspectives

Kazakhstan (ninth biggest country in the world and largest landlocked country) has an enormous territory, extensive natural resources, and multi-ethnic population. Due to substantial energy resources (especially oil and gas), Kazakhstan is an important player in socio-economic, geopolitical, and environmental development in Central Asia [36]. These specific features served as a primary call for the application of sustainable development theory to this country [36].

Intensive use of energy in the country generates adverse environmental impacts and, thus, overall economic growth is exposed to detrimental effects of climate change [28]. The high rates of economic growth resulted in side effects such as such as environmental pollution through industrial and household waste, a coal-based energy mix with an absence of renewable sources of energy, and a generally high energy intensity [28]. Pollution progressively limits quality of life in Kazakhstan, particularly in cities, where levels of air pollution from stationary and mobile sources are rising, and solid waste concern is growing. The population in rural areas suffer the most from these effects, as their income does not allow for costly substitutes or relocation [28]. It is anticipated that the frequency and magnitude of extreme climatic events such as heatwaves, heavy snow, sleet, and flood will likely increase [28].

Limited access to quality services and infrastructure outside the main cities provokes regional social and economic inequalities in Kazakhstan [28]. The country's urban infrastructure requires considerable modernization. In most secondary provincial centers, the water supply, wastewater, district heating, and urban road infrastructure have deteriorated. For instance, most regions demonstrate good indicators for access to water services; however, the services are often poor quality outside Nur-Sultan (Astana) and Almaty [28]. Another issue is access to sanitation services; in five regions, access has been reported below 50% of the population.

Since 2000, the economy of Kazakhstan has grown considerably. This success is primarily due to the increased production and exports of oil, minerals, and other commodities [28]. The economic perspective of Kazakhstan is closely connected to integration into global economic relations, application of unique energy reserves and mineral resources, and huge exporting possibilities. The main aims of current structural policy are diversification and enhancing the non-oil sector. As a result, a number of research centers and development institutions were established. These centers and institutions serve to further develop and diversify the country's economy. Hence, significant results have been achieved during the last 20 years, and Kazakhstan has gained macroeconomic stability, established fundamental legislation for successful business, and created a favorable environment for the increased development in the mid and long terms [28].

2.6. Commercial Buildings

Commercial buildings are considered a major indicator of the socio-economic development of any country. In recent years, the demand for space of commercial buildings has increased in Kazakhstan, especially in cities such as Nur-Sultan (formerly Astana), Almaty, Atyrau, and Shymkent. This is due to the growing number of business units and development of national companies [37]. According to the Kazakhstan Statistics Committee, the largest share of constructed buildings in Kazakhstan, up to 23%, are concentrated on non-residential building construction. The occupancy rate dynamics of commercial buildings in Nur-Sultan and Almaty has shown the average rate of 80% to 96%. It should be noted that this number is increasing.

Commercial buildings have a significant impact on social, environmental, and economic sustainability. According to a report by the World Bank [38], city-wide final energy consumption by commercial buildings in Nur-Sultan and Almaty is equal to 23% and 25%, respectively, whereas waste generated by commercial buildings equals to 14% of all solid waste produced in Kazakhstan. Electricity consumption by commercial buildings in Nur-Sultan is also quite high; about 30–40% higher than the average of selected other cities [38]. Statistics for water consumption in commercial buildings are also significant [38]. To date there are 25 BREEAM and LEED certified commercial buildings in Kazakhstan (mainly in the cities of Nur-Sultan and Almaty) [39]. These numbers indicate the green revolution boost in Kazakhstan in recent years.

3. Research Methodology

3.1. Research Design

The study adopted a qualitative approach to identify the assessment categories and assessment indicators for commercial buildings' sustainability in Kazakhstan. Literature review and Delphi technique were used as the main data collection sources. Two sets of assessment categories and indicators, initial and final, were developed. The initial set of assessment categories and indicators were identified based on the review of well-recognized assessment tools. The review attempted to focus on the elements of these tools and their implementations; and considered the local context of Kazakhstan in terms of the climatic and regional diversification, and project implementation peculiarities of the construction industry in Kazakhstan. A Delphi questionnaire survey was conducted to collect the information from the Architectural, Engineering and Construction (AEC) experts in Kazakhstan and to validate the final set of identified assessment categories and indicators. The main goal was to ensure the importance of each assessment item and its applicability to Kazakhstan's local context. Parameters of the assessment indicators are determined based on the National Building Codes requirements and with the industry experts' assistance. Statistical aggregation of questionnaire results was performed using SPSS software. The research design structure is illustrated in Figure 1.

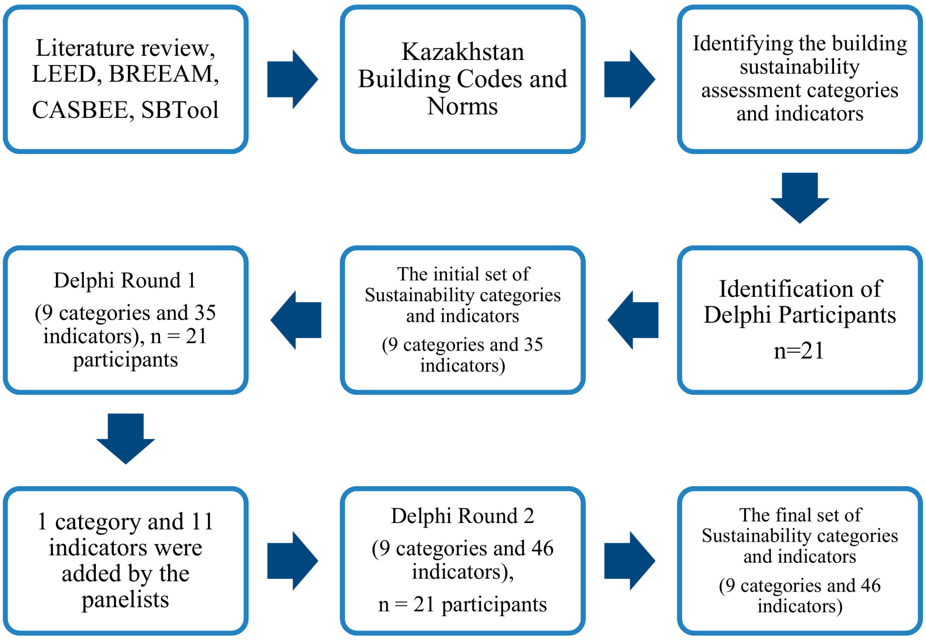

Figure 1. Research design.

3.2. *The Initial Set of Sustainability Categories and Indicators*

As presented in Table 1 below, there are a number of categories common in the rating systems of BREEAM, LEED, CASBEE, and SBTool. This research considered these key categories as a reference to be adjusted according to the context of Kazakhstan. It is important to note that in other studies [20,40,41], these categories are pointed out as critical and primary categories in all well-known green building assessment methods.

After carefully reviewing the international sustainability assessment methods and similar experiences, the study selected the following six categories: Site selection, indoor environmental quality, energy efficiency, water efficiency, waste, and materials. Then, considering the local conditions and building codes and construction norms, three more categories were added to the initial set of assessment criteria. The output yielded the following nine initial categories: (1) Construction site selection and infrastructure, (2) building architectural and planning solutions quality, (3) indoor environmental quality, (4) water efficiency, (5) energy efficiency, (6) green building materials, (7) waste, (8) social, and (9) economy. The overview of the common assessment items that were used as a benchmark for developing the initial set of assessment categories and indicators is summarized in Table 1.

These four assessment methods were chosen in this research based on the selection criteria according to [41]. Considering these criteria, all four rating systems are internationally recognized and have been successfully adopted by almost all of the developing countries [41]. These systems are well-known rating tools used globally by architecture, engineering, and construction industries; hence, using these tools as references will allow contractors and engineers to better understand the process and their contribution towards achieving sustainability criteria [9]. In the next stage of the research the categories and indicators of the framework will be allocated weights by experts in order to develop the multi-criteria decision-making tool. Thus, these criteria-based tools were chosen as a reference.

Table 1. Overview of assessment criteria of the benchmarked international tools.

Sustainable Categories	BREEAM	LEED	CASBEE	SBTool
Land and site ecology	Site selection; Public transport accessibility; proximity to amenities; cyclist facilities; maximum car parking capacity	Public transportation access; low-emitting, fuel-efficient vehicles; site development	Townscape and landscape; local characteristics and outdoor	Site development; urban design and infrastructure; Proximity to health care, public primary educational; public, social and recreation facilities. Proximity to small retail commercial facilities.
Water	Water consumption; water efficient equipment; water leak detection and prevention	Water use reduction; water efficient landscaping	Included in Resources and Materials	Included in Energy and Resource consumption
Energy	Energy monitoring; reduction of CO_2 emissions; Energy efficient equipment; External lighting	Commissioning; renewable energy production;	Efficiency in Building Service system; Efficient operation	Energy and Resource Consumption; Environmental loadings
Materials	Life-cycle impacts; material efficiency	Materials reuse; recycled content; regional materials	Materials of low environmental load	Included in Energy and Resource consumption
Indoor Environmental Quality	Visual comfort; thermal comfort; acoustic performance; accessibility	Daylight; thermal comfort; acoustic comfort	Thermal comfort; Noise and acoustics; lighting; air quality	Indoor air quality and ventilation; noise and acoustics; daylighting and illumination
Management	Commissioning and handover	N/A	Included in the Quality of Service	Included in Service Quality
Waste	Construction waste management; recycled aggregates; operational waste	Construction waste management;	N/A	Included in Environmental Loadings
Economic and social aspects	Life cycle cost; Service life planning	N/A	Financial viability; social vitality	Construction cost; operations and maintenance cost; life-cycle cost; affordability of rental or cost levels; social aspects

3.3. The Delphi Process

Delphi technique is a standardized and interactive research technique used to obtain a group of experts' perception or judgment on a specific topic [42]. It is an effective technique to reach general agreement in a cross-field research topic for new and complex concepts [43]. The Delphi in this study was performed in the following four stages: Designing the questionnaire and its validity check, selection of experts, survey, and analyzing the data (Figure 2).

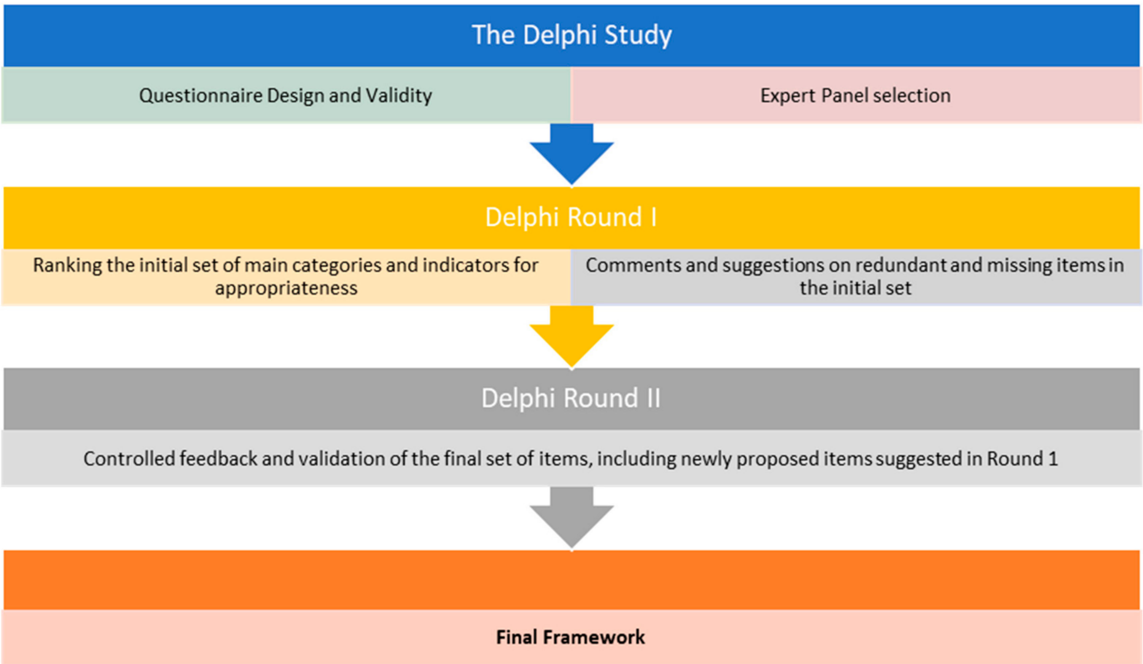

Figure 2. Delphi process flowchart.

A questionnaire was developed after the assessment categories and indicators were determined. Mostly, two to three rounds of Delphi survey are sufficient to achieve consensus among invited participants [44]. According to Skulmolski et al. [45], a 3-round Delphi study is the most appropriate for graduate research. Nevertheless, in the course of the research, it took much time to get the point of second round, and panelists were reluctant to continue after an agreement was achieved. The mean values were set at 75% (>3.80). Thus, it was decided to finish the study at the second round. Moreover, from other studies, it was observed that surveys are typically concluded within two rounds [46,47].

The first-round questionnaire survey had three main parts. The first section collected data on the respondent's demographic information including the background and the level of experience in the AEC industry and green building projects. The second section investigated nine categories with 35 related items, and respondents were asked to rate the relevance/importance of each factor on a five-point Likert scale based on: 1 = completely inappropriate, 2 = inappropriate, 3 = neutral, 4 = appropriate, and 5 = completely appropriate [48]. According to Gao et al. [49], Likert scale is an accepted rating format for surveys. At the end of each question, respondents were asked to provide any additional assessment item that they would consider appropriate and important or felt was missing. The third section intended to examine the sustainability-related issues specific to Kazakhstan construction industry. In addition, experts were asked to give some region-specific performance aspects of sustainability that would be critical for the development of the assessment framework. Copies of this questionnaire were then sent to four experts to check its validity.

After the first round survey, the results were examined and the responses were analyzed using SPSS to evaluate the agreement among respondents' answers. Also, considering the feedback and comments from panelists, some other Kazakhstan specific issues were added, replaced, and eliminated from the initial set of assessment criteria, and the panelists were asked to rank whether they agree with the final set of assessment items in the second round questionnaire, in the following scale: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree.

Delphi panel of experts from the construction industry were selected based on the following criteria: (i) Experience in the field of AEC and sufficient knowledge about sustainable building development; (ii) holder of a professional title as a manager, architect, engineer, or environmentalist/ecologist; and (iii) employment and membership in a design and construction organization in Kazakhstan. After the selection of participants that met the pre-defined criteria, they were contacted through email and phone calls. Out of 25 experts invited, 21 experts agreed to participate in the two-round Delphi survey. Delphi study was administered and carried out from July to September 2018, in which the experts received the questionnaire by email.

3.4. Delphi Panel Participants' Demographics

Twenty-one respondents participated in the Delphi survey including nine architects/engineers (43%), three owner/facility managers (14%), four contractors (19%), two experts from governmental organizations (10%), and three experts from academics (14%). Participants' demographics showed a high level of familiarity and experience with the AEC industry (Table 2).

Table 2. Background information on Delphi participants.

Organization	Position	Participant Number	Percentage	Experience in the AEC Industry	Number of Green Building Related Projects
Construction Organizations	Architect/Engineer	6 2 1	43	10–20 years 5–10 years +20 years	3–5 projects 6 projects
	Owner/Facility Manager	1 2	14	5–10 years 10–20 years	1–2 projects 1–2 projects
	Contractor	2 2	19	5–10 years 10–20 years	1–2 projects 3–5 projects
Governmental Organizations	Environmentalist	1 1	10	5–10 years 10–20 years	1–2 projects
Academics	Professor	1 1 1	14	5–10 years 10–20 years +20 years	3–5 projects 3–5 projects
Total		21	100		

Since the concept of sustainability is new to Kazakhstan and it is not very prevalent, there is a deficiency of experts with extensive knowledge in sustainable and green construction. Hence, the Delphi study involved 21 respondents who agreed to the authors' invitation out of the 25 invited experts that met the pre-defined criteria.

3.5. Statistical Aggregation of Delphi Survey Responses

For the purpose of obtaining a measure of consistency in the responses, mean and standard deviation values were calculated through SPSS. Mean values were used to identify the levels of the appropriateness of assessment items, whereas standard deviation expressed the level of agreement on one item amongst the Delphi panelists. The level of agreement decision criteria was set as follows: Standard deviation (SD) value from $0.00 \leq SD < 1.00$—high level of agreement, $1.00 \leq SD < 1.50$—reasonable/fair level, and $SD \geq 1.50$—no agreement [50].

4. Results and Discussion

In this section, a discussion of results is presented as follows: (1) Analyzing the initial set of sustainability categories and indicators; (2) the final set of sustainability categories and indicators; and (3) parameters of the proposed framework.

4.1. Initial Set of Sustainability Assessment Categories and Indicators

The initial set of assessment items consisted of nine categories and 35 indicators. The results of the first and second round Delphi technique are presented in Appendix A. From the first round, 100% agreement was reached on eight categories except social category. A new category 'management' was suggested by panelists. Fifteen experts (71%) pointed out that 'management' category was missing and suggested to add as a separate category. The panelists suggested to change indicators as follows: To include safety and inclusiveness of opportunities (SOC3) to the 'building architectural and planning solutions quality' category; 'education and awareness' (SOC2) to the 'management' category, and 'user health' (SOC1) indicator to the indoor environmental quality category. Also, new indicators were suggested as: Land use (CSI1), low-impact site construction (CSI2), natural ventilation (IEQ6), building water conservation (WE1), leak detection (WE3), water-efficient landscaping (WE4), water recycling and reuse (WE5), energy-efficient heating and cooling (EE3), greenhouse gases emissions (EE4), energy-efficient equipment (EE5), and energy savings through natural gas efficiency (EE7). For the 'management' category, the following four indicators were added: Environmental management certificate (MAN1), green building accredited expert (MAN2), designer's green building experience (MAN3), and contractor's green building experience (MAN4).

4.2. Final Set of Sustainability Assessment Categories and Indicators

The second round of Delphi aimed at validating the final set of assessment categories and indicators. In this round, no changes were suggested and it can be assumed that the overall standard deviation values demonstrate the high level of agreement among experts on the categories and indicators of the final set (Appendix A). Thus, the Delphi study could be completed after the second round. Since this study aimed to determine and explore region specific sustainability issues relevant to the local context of Kazakhstan, the unanimity among experts on each item expressed by the value of standard deviation was considered.

Analysis of the second round revealed that experts reached 100% agreement on items as 'thermal comfort' (IEQ1), 'daylighting' (IEQ2), 'energy efficient heating and cooling' (EE4), 'energy-efficient equipment' (EE5), 'energy saving—reduction of electricity consumption" (EE6), 'building operation and disposal impact'(WST2), 'building total lifecycle costs' (ECO1), and 'annual operating costs' (ECO2). The rest of the items had overall mean value greater than 3.80; thus, the final set of assessment categories and indicators was considered as validated.

Overall, the panelists agreed that the suggested criteria for assessing green buildings were efficient and appropriate for Kazakhstan. They felt that all the proposed assessment items were important and should be considered in the assessment framework. No other assessment items were suggested. Finally, 9 categories and 46 assessment indicators were selected as a final set (Table 3).

Table 3. The final set of sustainability assessment categories and indicators.

Assessment Categories	Assessment Indicators
Construction site selection and Infrastructure	Land use (CSI1) Low-impact site construction (CSI2) Access to social, domestic, and socio-economic facilities (CSI3) Access to public and ecological transport (CSI4) Greenspace (CSI5) Landscape irrigation (CSI6) Visual comfort (CSI7)
Building architectural and planning solutions quality	Building architectural appearance quality (BAS1) Building form and orientation (BAS2) Greening the building (BAS3) Useful floor space (BAS4) Parking capacity (BAS5) Safety and inclusiveness of opportunities (BAS6)
Indoor Environmental Quality	Thermal comfort (IEQ1) Daylighting (IEQ2) Insolation level (IEQ3) Acoustic comfort (IEQ4) Noise protection (IEQ5) Air pollution monitoring (IEQ6) Natural ventilation (IEQ7) User health (IEQ8)
Water efficiency	Building water conservation (WE1) Application of innovative water efficient equipment (WE2) Leak detection (WE3) Water-efficient landscaping (WE4) Water recycling and reuse (WE5)
Energy efficiency	Building commissioning (EE1) Renewable energy sources use (EE2) Greenhouse gases emission (EE3) Energy-efficient heating and cooling (EE4) Energy-efficient equipment (EE5) Energy saving—Reduction of electricity consumption (EE6) Energy saving—Natural gas efficiency (EE7)
Green Building Materials	Local/regional building materials (GBM1) Recycled materials (GBM2) Secondary use of recycled materials (GBM3)
Waste	Construction waste management (WST1) Building operation and disposal impact (WST2)
Economy	Building total lifecycle costs (ECON1) Annual operating costs (ECON2) Affordability (ECON3)
Management	Environmental management certificate (MAN1) Green building Accredited expert (MAN2) Designer's green building experience (MAN3) Contractor's green building experience (MAN4) Education and awareness (MAN5)

4.3. Parameters of the Assessment Framework

Generally, the assessment tool consists of categories, assessment indicators, and parameters that define the assessment indicators. Each assessment indicator in the developed framework is determined by numbers of parameters. These parameters were identified based on the National Building Codes requirements and with the assistance of the industry experts. The following National Building Codes were used to identify the parameters (Table 4):

Table 4. Referenced building codes.

No	Building Code Number	Building Code Title
1	SNiP RK 3.01-01-2008	"Urban planning Layout and development of urban and rural communities"
2	SNiP RK 2.04-05-2002	"Natural and artificial lighting"
3	SNRK 3.02-38-2013	"Energy Efficient Buildings"
4	SNIP RK 3.02-07-2014	"Public Buildings"
5	CN RK 2.04-04-2011	"Building Thermal Protection"
6	№ 3.01.077.00-2000	Sanitary norms of the Republic of Kazakhstan
7	SP RK 2.04-105-2012	"Design insulation shells of residential and public buildings"
8	SN RK 2.04-02-2011	"Noise Protection"
9	SNiP RK 4.01-02-2009	"Water Supply"
10	RDS RK 1.03-04-2011	"Commissioning works"
11	SNiP RK 4.02-42-2006	"Heating, Ventilation and Air Conditioning"

The categories and indicators of the proposed building sustainability assessment framework for commercial buildings in Kazakhstan are described as follows.

4.3.1. Construction Site Selection and Infrastructure Category

According to the Building code "Urban planning. Layout and development of urban and rural communities" in Kazakhstan, the functional purpose of the facility being constructed should strongly correspond to the land use category. Further it is stated that appropriate selection of construction site is important to form a fully fledged comfortable environment and life for occupants and provide sustainable development of communities. Therefore, the land use and construction site with low negative impact to the environment are critical indicators that determine the construction site selection category. According to Delphi experts' suggestions, these two indicators were added to the proposed framework. The main aim of land use indicator (CSI1) is to use the land for construction in accordance with the functional purpose of the land, which is situated outside the zones of any other facilities and structures. Also, the land spot should be located in the area with existing public utilities prior to the commencement of construction. Low-impact site construction (CSI2) aims to minimize the impact of construction activity through the selection of land spot that has been previously occupied by buildings and infrastructure at least for 50%. Also, this indicator includes the actions to protect and restore the environment during the construction process, such as protection of roots of trees, recultivation of the fertile soil, and 100% compensatory landscaping of destroyed plantations. Access to social and socio-economic facilities (CSI3) is defined by the number of available basic services within 800 m of the building entrance. The basic services include bank, post office, pharmacy, medical office, school, place of worship, supermarket, grocery, restaurant, laundry, fire station, etc. Access to public transport (CSI4) encourages and rewards a building location that promotes the reduction of environmental impact resulting from the building user travels. The following walking distances from the building entrance to bus stops are determined for evaluation: Less than 200 m, 200 to 300 m, and 300 to 500 m. Access to ecological transport (CSI4) aims to encourage building users to use eco-friendly transport and reduce transport-related emissions and traffic congestion. Bicycle parking and electric vehicle parking spaces are included in the proposed framework as the main types of eco-friendly transport. Greenspace (CSI5) is determined by the percentage ratio of the green area to the total construction site. Delphi experts agreed with the greenspace ratio percentage given in the framework and believe that the aim of the greenspace development is to create the natural surrounding and limit the heat island effect. In addition, this criterion encourages the vertical gardening of the building. Landscape irrigation (CSI6) is defined by the type of equipment used for the land irrigation, including automated system with drain batteries, water tap sprinkler, and garden tap. Visual comfort (CSI7) aimed to provide favorable emotional conditions for users and is measured by the lack of monotonous landscape, facades, roofs, windows, and interior. Experts assessed the achieved visual comfort in three levels—excellent, good, and satisfactory.

4.3.2. Building Architectural and Planning Solutions Quality Category

Building architectural and planning solutions are defined as the author's intention of the facility that includes a complex solution of constructive, functional, and esthetic requirements for it, as well as, economic, social, ecological, sanitary-hygienic, engineering, and technical features fixed in the architectural part [51].

The objective of this category is to ensure that the building architectural appearance fits the surrounding environment and its functional purpose and aesthetic requirements with architectural originality, uniqueness, and architectural novelty. Further, this aspect addressed indicators such as building form and orientation (BAS2), which has an impact on energy efficiency of the building facility. Catalina et al. [52] investigated the influence of building form on the energy use through the lighting and thermal simulations performed on different office building shapes and found a difference in the lighting visual comfort of more than 30% and reduced heating demand by 6–10% depending on the compactness of the building form. Recently, a similar study by Wei et al. [53] focused on the impact of building form on energy consumption regions with cold climate. Using input criterion like orientation of building, window-to-wall ratio, and overall building scale, the study concluded that the overall building scale was the most important factor that influenced both cooling and electricity consumption per unit of floor area. Therefore, in the proposed framework, optimization of building form and orientation in all four climatic zones should be one of the significant factors identifying building architectural planning quality, especially in the regions in Kazakhstan with extreme weather conditions in winter and summer. Another aspect in this category is greening the building (BAS3). It can be performed through the green roofs and vertical greening. Green roofs have numerous proven environmental, social, and economic benefits such as improved building insulation, storm water depletion, noise insulation, heat-island effect mitigation, extended roof life, habitat for pollinators, aesthetic value, enhanced property marketability, and improved air quality [54,55]. Vertical greening is another emerging field, promising for facing the negative effects of climate change [56]. Green roofs and vertical greening are not common in Kazakhstan and having them as a sub parameter of the performance indicator in the assessment framework would enhance and promote the use of these systems for better environment and cleaner cities. Useful floor space (BAS4) in accordance with the national building codes is another vital parameter of providing the sufficient zone for users to work in the building. Useful floor space is measured by a unit floor area per occupant in the building. For commercial buildings, unit floor area varies between 10–15 m^2. Parking capacity (BAS5) is addressed in LEED and BREEAM as one of the important factors intended to reduce pollution and land development impacts from automobile use. In the proposed framework, this indicator had the same intent and was determined by the number of employees per passenger car equivalent.

Another critical criterion is safety and inclusiveness of opportunities (BAS6). Spaces should be designed in a way to enhance connectivity to all building occupants including disabled, healthy, and elderly persons, in addition to the requirements of Building Code SP RK 3.06-101-2012 "Design of buildings with accessibility for minor mobile group of population".

4.3.3. Indoor Environmental Quality Category

This category aims to achieve the increased comfort, health, and safety of building occupants, visitors, and other users. Due to the fact that, nowadays, people spend 90% of their time indoors, it is critical to ensure comfort within the building. This category is one of the most common and important in all existing assessment methods including BREEAM, LEED, and SBTool. Indoor environmental quality (IEQ) has considerable influence on productivity and wellbeing of office occupants. In the indoor environmental quality category, there are seven determining indicators and 18 parameters. Thermal comfort (IEQ1) aims to create a desirable state of occupants in the building. In the proposed framework, it is measured by the heating, ventilation, and air conditioning system zoning in the building. Daylighting (IEQ2) indicator aims at providing sufficient natural lighting in the building in accordance with the minimum regulatory requirements of Building Code of Republic of Kazakhstan "Natural and Artificial lighting". Daylighting is divided into side, top, and combined (side and top). Depending on the coefficient of natural lighting, location of window openings for daylight the building is determined. Insolation level (IEQ3) is determined by sunlight provision according to the existing sanitary norms expressed in percentage (>120%, 111% to 120%, and 105% to 120%). Acoustic comfort (IEQ4) is determined by the involvement of an acoustic expert, which confirms the compliance of building to requirements for buildings of category A according to MSN 2.04-03-2005 Noise Protection. Acoustic comfort is measured by the indoor ambient noise levels during daytime and nighttime. Noise protection (IEQ5) is measured by the maximum outdoor noise levels during day and night set by the building code. Air quality (IEQ6) is assessed by the concentration of volatile components and air exchange in the building expressed in meter cubes per square meter. Natural ventilation (IEQ7) is evaluated by the passive cooling system used in the building during the nighttime.

Air pollution monitoring is the most critical aspect in this category due to the high dependence on fossil fuel use in Kazakhstan. As a result of fossil fuel energy consumption, indoor environment is contaminated through the penetrated air from the outdoor environment. Considering this fact, it is recommended mandatory to have air pollution monitoring measures in buildings.

4.3.4. Water Efficiency Category

Water is a unique liquid that plays an important role in sustaining any built environment and the human activities. All of the existing assessment systems in developed and developing countries addressed issues related to water. Both BREEAM and LEED emphasize sustainable potable water use and reduction over the building lifetime. Water consumption is important both in residential and non-residential buildings. Therefore, this category encourages the efficient use of water during operation of the building and its site. Water scarcity is one of the key environmental problems preventing sustainable development of Kazakhstan. Water system in Kazakhstan is unique and vulnerable and exposed to external risks. As a consequence of raising water need and reducing sustainable water supply, there is an anticipated water shortage of 14 bcm by 2030 and 20 bcm by 2050 if no measures will be taken. Hence, the consequences of water shortage can become a major barrier to sustainable economic prosperity and social improvement in Kazakhstan. Thereby, it is anticipated that water conservation through the building sustainability assessment will be an on-time measure to prevent the global threat as water deficit. The proposed framework recommends employing the following strategies and measures to reduce the amount of water used at the facility. The main objective of this category is to reduce the potable water consumption through the installation of water efficient equipment including ultra-low flow toilets and urinals, low-flow or censored sinks, and other innovative technologies. Leak detection (WE3) system is also recognized as an effective measure to conserve the potable water use. The proposed framework recommends using a leak detection system with visual and sound signals. Water-efficient landscaping and irrigation systems (WE4) are a crucial measure to save the water use in the building. For instance, rainwater and storm water can be used for irrigation and landscaping in Astana and Almaty cities, where the annual precipitation levels are 320 mm and 581 mm, respectively [30]. In addition, it is suggested to implement the greening of the territory without irrigation by using plants adapted to local climatic conditions that do not require everyday watering. Another measure is recycling and reuse (WE5) of grey water and storm water for technical needs in the buildings. According to survey results, this measure is effective for considerable reduction of potable water consumption in the building.

4.3.5. Energy Efficiency Category

The building industry is one of the leading energy consumers in the world [57]. Energy consumption and production process is accompanied by excessive use of other resources and emissions; thus, becoming one of the critical concerns for the building lifecycle, and therefore almost all environmental sustainability assessment methods address sustainable energy use. Similarly, energy efficiency is crucial in Kazakhstan, since the country's economy is highly energy intensive and, as a result, Kazakhstan is the greatest greenhouse gas emitter in the Central Asia [31]. In addition, having a vast potential for renewable energy, it uses only 0.6% of renewable resources for energy production. Hence, one of the main priorities in the transition to Green Economy program and Strategy Kazakhstan 2050 is to reach energy efficiency through alternative sources of energy. A proper building commissioning (EE1) process is the first performance indicator recommended to maximize the energy efficiency. Experts agreed that building commissioning is essential for adequate operation and performance of energy systems in buildings. All four climatic zones can benefit from the renewable resources potential (EE2) in Kazakhstan. These include hydro, solar, biomass, wind, and nuclear resources. Hydro resources in Kazakhstan can be grouped into three regions, such as Irtysh River Basin, the Southern-Eastern zone, and the Southern zone. Total hydro power potential is estimated 170 TWh annually with only 13–15% of it being utilized effectively [34]. Currently, Kazakhstan has large (>50 MW), medium (10–50 MW), and small (<10 MW) hydro stations with installed capacity of 2.2 GW and 78 MW, respectively [58]. The country is enriched with solar resources, with annual solar radiance differing between 2200 to 3000 h of sunlight yearly, resulting in annual solar potential of 1300 kWh/m^2 and 1800 kWh/m^2 [34]. Maximum solar activity of 1750 kWh/m^2 is concentrated in southern Kazakhstan, whereas the smallest solar radiation of less than 1150 kWh/m^2 is in the north of the country. Therefore, southern regions can benefit from solar energy through installing the PV panels.

The country is blessed with excellent wind resources. Over 50,000 km^2 of territory over nine regions has good enough wind resource with average wind speed of 4–6 m/s. Central and northern regions have been found to be the areas with the highest wind potential [25]. Thus, the first climatic zone can benefit from wind resources the most. Thus, all 16 regions within four climatic zones can substantially benefit from the country's renewable energy resources potential. Especially, solar, hydro, and wind energy technologies pointed out to be suggested in the framework.

Due to the high energy consumption in Kazakhstan, respondents suggested to add greenhouse gas emissions indicator (EE3) to the framework as it is crucial for country's sustainable development. According to statistics, Kazakhstan is the largest GHG emitter in central Asia, and the government set the reduction of CO_2 emissions as one of the priorities towards sustainable development of the country. Also, in 2018, Kazakhstan launched the online system that monitors the GHG emission sources. This was the essential part in implementing the program on National Emissions Trading System of Kazakhstan that was introduced in 2013 as the major mechanism for internal CO_2 emissions regulation and low-carbon technologies development.

Efficiency of heating and cooling equipment (EE4) plays an important role in order to reach energy-efficient buildings. One reason for heat loss is improper air sealing or insufficient insulation. Thus, attention should be paid to adequate sealing and insulation of building envelope. Also, heat loss through windows should be considered. Another suggestion is to use energy-saving windows in commercial buildings.

Energy-efficient equipment (EE5) in the buildings is also considered as an identifying parameter of this category. For this purpose, the framework suggests using energy-efficient equipment with a class of energy efficiency not lower than "A", including office equipment, electric and water heaters, and electric stoves and ovens in office canteen. Energy savings by reducing the electricity use (EE6) is another indicator that was rated as important by Delphi experts. Experts believed that using energy-efficient lighting fixtures and energy-efficient elevators can significantly decrease the electricity consumption. As mentioned before, Kazakhstan has natural gas resources potential. According to EnergyProm [59], in 2017, natural gas extraction in the country had reached 35.3 billion cubic meters, which is 17.3% more than in previous year. Natural gas reserves are mainly located in Atyrau, Aktobe, Mangystau, Kyzylordynskaya, Zhambyl, and West and East Kazakhstan oblasts. Thus, almost all regions in Kazakhstan can benefit from natural gas energy. According to expert feedback, using natural gas for electricity production will have a tremendous effect on cost benefits, social comfort, and environment protection.

4.3.6. Green Building Materials Category

The aim of this category is to reduce the environmental impact of building materials through the use of local building materials, thereby reducing the environmental threat to the ecosystem resulting from transportation of the building materials. Construction activities inevitably generate a substantial amount of solid waste from the production, transportation, and consumption of materials [60]. In addition to many pollutants to air, water, and land, the construction sector is a huge consumer of raw materials. Therefore, considering the environmental impact of building materials is critical. It is believed that recommending the use of local building materials (GBM1) will enhance the production of green certified building materials domestically in Kazakhstan, which will promote and develop new jobs, positively influencing the local economy in regions. In addition, this will enable the creation of the green building certified materials database in Kazakhstan. According to [28], 50% of major construction materials including windows, heat insulation, and copper pipes are imported to Kazakhstan. Hence, enhancing the production of such materials domestically would create up to 150,000 new jobs by 2030. This indicator is determined through the parameters showing the percentage of local materials used in the building. This category further encourages the secondary use of recycled materials so that the impact resulting from extraction and processing of virgin materials can be reduced, and construction waste can be minimized. Therefore, suggestions in the framework on recycling (GBM2) and secondary use (GBM3) of construction waste including concrete, brick, wood, glass and glass fiber, and metals will inform and raise the interest of building materials' manufacturers to develop the recycling process.

4.3.7. Waste Category

Issues like waste and pollution have been assessed in all sustainability assessment tools due to the harmful effect to the ecosystem from construction activities. Since waste management is one of the major concerns in Kazakhstan, construction waste management is considered as an important issue. As previously mentioned, 97% of solid waste is dumped uncontrolled and without processing in the landfills [28]. There have been studies on municipal waste statistics in Kazakhstan. However, this statistics lacks the information about the construction generated waste in Kazakhstan. Thus, this category and its determining assessment indicators will enlighten the interest of academia and industry to further research the construction waste management in Kazakhstan. Global practice demonstrates that the waste management and recycling field is highly labor intensive and requires qualified engineering specialists. So, this would be another opportunity to create up to 8000 new jobs by 2030 in collecting and waste recycling across Kazakhstan [33]. In addition, this category intends to minimize the construction waste through the sorting of construction solid waste for secondary use and recycling. Also, this category encourages lessening the building operation and disposal impact through the use of machine and mechanisms on eco fuel or electricity. In addition, it requires the presence of ecology certificate for engineering equipment used in the building.

4.3.8. Economy Category

This aspect addresses building total lifecycle costs (ECON1), including construction, operation, and maintenance costs. In order to identify the economic sustainability of the building, the framework proposes comparing the estimated costs of the designed green building to the conventional building costs in order to determine the total lifecycle costs. Annual maintenance costs (ECON2) and building exploitation costs including heating and electricity consumption costs are crucial factors to be compared to the conventional analogous of the facility. Also, it takes into account an affordability of the buildings.

Affordability of commercial buildings is identified with rental affordability (ECON3) of the building spaces in green facilities. Performance assessment tools in developed countries address these issues poorly. However, in emerging countries, along with environmental consideration, there is a necessity to pay a lot of attention to the economic aspect.

4.3.9. Management Category

This category was added as per experts' suggestions. The first indicator in this category is the presence of an environmental management certificate of the general contractor (MAN1). A systematic approach to environmental management would allow for mitigating and reducing the negative effect of the project on the environment and at the same time improve socio-economic interest.

According to survey results, sustainability and green building-related experience of design organization and contractor is critical for successful implementation of the project. Also, experts claimed that the project led and delivered under the green building accredited professional's control will be more beneficial. It is also believed that having these points in the framework will further raise the interest of contractor organizations to learn and educate their staff about new trends and advanced technologies in green building construction implemented in developed countries. Including a social aspect in the framework is crucial because in addition to providing health and wellbeing of occupants and building users, there is an urgent need to educate and raise an awareness of the public on how to use green buildings. Thereby, the education and awareness (MAN5) indicator was suggested to enhance tenants' and occupants' participation in conserving energy, water, and reducing waste. This point is also important due to the fact that sustainability is a new concept in Kazakhstan.

5. Conclusions

This paper aimed to establish a framework for building sustainability assessment for commercial buildings in Kazakhstan. Well-recognized and broadly used international sustainability assessment methods such as BREEAM, LEED, SBTool, and CASBEE were reviewed for common assessment items and adapted with respect to the local construction implementation process and regional conditions in Kazakhstan. The outcome is the proposed framework that consists of nine categories, 46 defining performance indicators, and 142 parameters. These categories include construction site selection and infrastructure development, building architectural and planning quality, comfort, indoor environmental quality, water efficiency, energy efficiency, green building materials, waste, economy, and management.

The assessment framework considered local climatic zoning, construction project implementation peculiarities, and regional-specific conditions in Kazakhstan. Renewable resources potential in the country and building materials-related opportunities were also considered. The proposed framework has been verified and validated based on the experience and intensive knowledge of the Kazakhstan construction experts using the Delphi study. The scope of this research was limited to commercial buildings, only taking into consideration environmental, social, and economic aspects of sustainable development.

This paper demonstrated the results of the first phase of the research work on developing the Building Information Modelling (BIM) based building sustainability assessment tool in Kazakhstan—development of the main categories and indicators of the assessment framework. Thus, this research paper is limited to the verification and validation of the main assessment criteria.

Another limitation of the research is the number of Delphi participants. Since the concept of sustainability is just evolving in Kazakhstan, there is a deficiency of experts in the field of sustainable construction. Also, only Kazakhstan AEC industry experts participated in the Delphi survey. Therefore, in order to expand the assessment framework proposed in this study, the next stage of this research could involve a broader survey in terms of a number of participants and include international AEC experts from other countries of Commonwealth of Independent States such as Russia, Ukraine, and Belarus. In addition, further insight can be brought by including the building users and occupants to analyze the proposed framework.

In addition, only four rating systems were used in the research as a benchmarking reference, which also might have influenced the results. This is a limitation of the research; if more rating systems were used, the results would have been different.

The main contribution of the research to the industry is providing the policy and decision makers with a tool that can be implemented to identify the current sustainability of buildings. The contribution of the research to the body of knowledge is the development of building sustainability assessment framework as a step towards establishing a generic working sustainability assessment tool that can be implemented within the Commonwealth of Independent States countries that share the same climatic zoning and similar building codes.

The proposed framework will serve as a starting point for developing a more comprehensive National/Regional commercial and institutional building sustainability assessment tool, and aid policymakers and designers to create sustainable buildings in Kazakhstan. In addition, implementation of the green building assessment will further raise the awareness of the construction industry participants and promote the sustainable development of the building sector. This will result in the formation and development of new jobs, thus positively impacting the social and economic development of the country and nation as a whole.

The next phase of the research will focus on weighing the assessment categories and indicators within the local context by the application of multi-criteria decision-making method (MCDM) and test the final framework through the pilot study.

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Appendix A

Table A1. The initial and final sets of assessment categories and indicators of the proposed framework.

Assessment Categories	Old Code	Round 1		Assessment Indicators	New Code	Round 2		Changes by Panelists	Level of Agreement
		Mean	SD			Mean	SD		
Construction site selection and Infrastructure	-	-	-	Land use	CSI1	4.71	0.46	•	High
	-	-	-	Low impact site construction	CSI2	4.80	0.40	•	High
	CSI1	4.48	0.68	Access to social, domestic and socio-economic facilities	CSI3	4.57	0.67		High
	CSI2	4.86	0.47	Access to public and ecological transport	CSI4	4.80	0.40		High
	CSI3	4.76	0.43	Greenspace	CSI5	4.66	0.57		High
	CSI4	4.57	0.67	Landscape irrigation	CSI6	4.19	0.74		High
	CSI5	4.38	0.74	Visual comfort	CSI7	3.80	0.98		High
Building architectural and planning solutions quality	BAS1	4.29	0.64	Building architectural appearance quality	BAS1	4.00	0.77		High
	BAS2	4.33	0.73	Building form and orientation	BAS2	4.57	0.67		High
	BAS3	4.71	0.46	Greening the building	BAS3	4.61	0.49		High
	BAS4	4.86	0.35	Useful floor space	BAS4	4.71	0.46		High
	BAS5	2.19	0.81	Space planning quality	BAS5	3.90	0.88		High
	BAS6	4.86	0.35	Parking capacity	BAS6	4.57	0.59		High
	SOC2	4.67	0.483	Safety and inclusiveness of opportunities	BAS7	4.80	0.40	•	High
Indoor Environmental Quality and comfort	IEQ1	4.81	0.402	Thermal comfort	IEQ1	5.00	000		High
	IEQ2	4.62	0.498	Daylighting	IEQ2	5.00	000		High
	IEQ3	4.67	0.483	Insolation level	IEQ3	4.57	0.5		High
	IEQ4	4.71	0.463	Acoustic comfort	IEQ4	4.14	0.91		High
	IEQ5	4.62	0.498	Noise protection	IEQ5	4.71	0.46		High
	IEQ6	4.86	0.359	Air pollution monitoring	IEQ6	4.57	0.59		High
				Natural ventilation	IEQ7	4.66	0.48	•	High
Water efficiency				User-health	IEQ8	4.54	0.53	•	
	WE1	4.71	0.463	Building water supply/conservation	WE1	4.85	0.35	•	High
	WE2	4.62	0.498	Application of innovative water efficient equipment	WE2	4.71	0.46		High
	WE3	4.38	0.498	Wastewater treatment	-	-	-	•	-
		-	-	Leak detection	WE3	4.76	0.43	•	High
		-	-	Water efficient landscaping	WE4	4.61	0.49	•	High
		-	-	Water recycling and reuse	WE5	4.00	0.70	•	High

Table A1. *Cont.*

Assessment Categories	Old Code	Round 1		Assessment Indicators	New Code	Round 2		Changes by Panelists	Level of Agreement
		Mean	SD			Mean	SD		
Energy efficiency	EE1	4.05	0.669	Building commissioning	EE1	4.19	0.67		High
	EE2	4.48	0.680	Renewable energy sources use	EE2	4.52	0.51		High
	EE3	4.71	0.463	Effective use of heat in places of consumption				•	
		-	-	Greenhouse gases emission	EE3	4.52	0.51	•	High
		-	-	Energy efficient heating and cooling	EE4	5.00	000	•	High
		-	-	Energy efficient equipment	EE5	5.00	000	•	High
	EE4	4.76	0.436	Energy saving—Reduction of electricity consumption	EE6	5.00	000		High
				Energy saving—Natural gas efficiency	EE7	4.27	0.71	•	High
Green Building Materials	GBM1	4.67	0.483	Local/regional building materials	GBM1	4.38	0.49		High
	GBM2	4.38	0.740	Recycled materials	GBM2	4.95	0.21		High
	GBM3	4.76	0.436	Secondary use of recycled materials	GBM3	4.04	0.80		High
Waste	WST1	4.71	0.463	Construction waste management	WST1	4.95	0.21		High
	WST2	4.62	0.590	Building operation and disposal impact	WST2	5.00	000		High
Economy	ECO1	4.48	0.680	Building total lifecycle costs	ECO1	5.00	000		High
	ECO2	4.57	0.598	Annual operating costs	ECO2	5.00	000		High
	ECO3	4.62	0.498	Affordability	ECO3	4.47	0.51		High
Management		-	-	Environmental management certificate	MAN1	4.14	0.65	•	High
		-	-	Green building Accredited expert	MAN2	4.66	0.48	•	High
		-	-	Designer's green building experience	MAN3	4.71	0.46	•	High
		-	-	Contractor's green building experience	MAN4	4.76	0.43	•	High
	SOC3	4.57	0.676	Education and awareness	MAN5	4.66	0.57	•	High

References

1. Rode, P.; Burdett, R.; Soares Gonçalves, J.C. Buildings: investing in energy and resource efficiency. In *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication*; United Nations Environment Programme: Nairobi, Kenya, 2011; pp. 331–373.
2. Wang, H.; Zhang, X. An analysis on the resource consumption in the Chinese construction industry. *Constr. Econ.* **2008**, *1*, 7–11.
3. Weerasinghe, U.G.D. Development of a Framework to Assess Sustainability of Building Projects. Ph.D. Thesis, University of Calgary, Calgary, AB, Canada, 2012.
4. Diaz-Sarachaga, J.M.; Jato-Espino, D.; Alsulami, B.; Castro-Fresno, D. Evaluation of existing sustainable infrastructure rating systems for their application in developing countries. *Ecol. Indic.* **2016**, *71*, 491–502. [CrossRef]
5. Cole, J. Building Environmental Assessment Methods—A Measure of Success. 2003. Available online: http://citeseerx.ist.psu.edu/viewdoc/citations?doi=10.1.1.486.5674 (accessed on 28 June 2018).
6. Ando, S.; Arima, T.; Bogaki, K.; Hasegawa, H.; Hoyano, A.; Ikaga, T. *Architecture for a Sustainable Future*; Architectural Institute of Japan: Tokyo, Japan, 2005.
7. Alshamrani, O.S.; Galal, K.; Alkass, S. Integrated LCA–LEED sustainability assessment model for structure and envelope systems of school buildings. *Build. Environ.* **2014**, *80*, 61–70. [CrossRef]
8. Nguyen, B.K.; Altan, H.A. Comparative review of five sustainable rating systems. *Procedia Eng.* **2011**, *21*, 376–386. [CrossRef]
9. Zarghami, E.; Azemati, H.; Fatourehchi, D.; Karamloo, M. Customizing well-known sustainability assessment tools for Iranian residential buildings using Fuzzy Analytic Hierarchy Process. *Build. Environ.* **2018**, *128*, 107–128. [CrossRef]
10. World Green Building Council. Available online: https://www.worldgbc.org/ (accessed on 20 October 2018).
11. Cole, R.J. Building environmental assessment methods: Redefining intentions and roles. *Build. Res. Inf.* **2005**, *33*, 455–467. [CrossRef]
12. Lee, W.L.; Burnett, J. Customization of GBTool in Hong Kong. *Build. Environ.* **2006**, *41*, 1831–1846. [CrossRef]
13. Ding, G.K. Sustainable construction—The role of environmental assessment tools. *J. Environ. Manag.* **2008**, *86*, 451–464. [CrossRef] [PubMed]
14. Gou, Z.; Xie, X. Evolving green building: Triple bottom line or regenerative design? *J. Clean. Prod.* **2017**, *153* (Suppl. C), 600–607. [CrossRef]
15. Cole, R. Building environmental assessment methods: Clarifying intentions. *Build. Res. Inf.* **1999**, *27*, 230–246. [CrossRef]
16. Darus, Z.M.; Hashim, N.A.; Salleh, E.; Haw, L.C.; Rashid, A.K.A.; Manan, S.N.A. Development of rating system for sustainable building in Malaysia. *WSEAS Trans. Environ. Dev.* **2009**, *5*, 260–272.
17. Banani, R.; Vahdati, M.M.; Shahrestani, M.; Clements-Croome, D. The development of building assessment criteria framework for sustainable non-residential buildings in Saudi Arabia. *Sustain. Cities Soc.* **2016**, *26*, 289–305. [CrossRef]
18. 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]
19. Vyas, G.S.; Jha, K.N. Identification of green building attributes for the development of an assessment tool: A case study in India. *Civ. Eng. Environ. Syst.* **2016**, *33*, 313–334. [CrossRef]
20. 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]
21. Shad, R.; Khorrami, M.; Ghaemi, M. Developing an Iranian green building assessment tool using decision-making methods and geographical information system: Case study in Mashhad city. *Renew. Sustain. Energy Rev.* **2017**, *67*, 324–340. [CrossRef]
22. About Ecoprojects. Available online: https://forbes.kz/process/ecobusiness/molodoy_i_zelenyiy/ (accessed on 28 June 2018).
23. Global Green Initiatives in Kazakhstan. 2018. Available online: https://kapital.kz/gosudarstvo/68657/globalnaya-zelenaya-iniciativa-doshla-do-kazahstana.html (accessed on 1 June 2018).
24. United Nations Development Programme. *Promoting Energy Efficiency in the Residential Sector in Kazakhstan: Designing a Public Investment Programme*; United Nations Development Programme: New York, NY, USA, 2012.

25. United Nations Development Programme. Renewable Energy Snapshot: Kazakhstan. Available online: http://www.eurasia.undp.org/content/dam/rbec/docs/Kazakhstan.pdf/ (accessed on 10 July 2018).
26. *Ratio Analysis of Construction Industry of Kazakhstan*; JSC "Rating agency of the Regional Financial Center of Almaty" Report: Almaty, Kazakhstan, 2016.
27. United Nations Development Programme. *Environment and Development Nexus in Kazakhstan*; UNDP: Almaty, Kazakhstan, 2004.
28. Country Partnership Strategy: Kazakhstan 2017–2021. Inclusive and Sustainable Growth Assessment. Available online: https://www.adb.org/sites/default/files/institutional-document/357421/cps-kaz-2017-2021.pdf (accessed on 10 June 2018).
29. World Climate Guide. Available online: https://www.climatestotravel.com/ (accessed on 25 May 2018).
30. Construction Codes and Regulations of Republic of Kazakhstan. SP RK 2.04-01-2017 - *Building Climatology*. Available online: https://igis.kz/images/snip/stroitelnye-normativy/sp-rk-2.04-01-2017-stroitelnaya-klimatologiya.pdf (accessed on 9 August 2019).
31. Country Partnership Strategy: Kazakhstan 2012–2016. Sector Assessment Summary: Energy. Available online: https://www.adb.org/sites/default/files/institutional-document/33638/files/cps-kaz-2012-2016.pdf/ (accessed on 12 June 2018).
32. British Petroleum Statistical Review of World Energy. Full report. 2017. Available online: https://www.bp.com/content/dam/bp-country/de_ch/PDF/bp-statistical-review-of-world-energy-2017-full-report.pdf (accessed on 20 June 2018).
33. Ministry of Environmental Protection of Republic of Kazakhstan. *Concept for Transition of the Republic of Kazakhstan to Green Economy*; Ministry of Environmental Protection of Republic of Kazakhstan: Astana, Kazakhstan, 2013.
34. Dahl, C.; Kuralbayeva, K. Energy and the environment in Kazakhstan. *Energy Policy* **2001**, *29*, 429–440. [CrossRef]
35. Brief Information on the Implementation of Sustainable Development Goals in Kazakhstan. 2017. Available online: https://egov.kz/cms/en/articles/development_goals (accessed on 23 July 2019).
36. Thomas, M. Social, environmental and economic sustainability of Kazakhstan: A long-term perspective. *Cent. Asian Surv.* **2015**, *34*, 456–483. [CrossRef]
37. Colliers International. 2018. Available online: http://colliers.kz/wp-content/uploads/2019/02/Ofisyi-Almatyi-4K-2018-final-to-print.pdf/ (accessed on 10 April 2019).
38. World Bank. *Kazakhstan: Energy Efficiency Transformation in Astana and Almaty*; Municipal Energy Efficiency Plan for the City of Astana; World Bank: Washington, DC, USA, 2017.
39. The Green Building Information Gateway. 2019. Available online: http://www.gbig.org/places/691/activities (accessed on 24 February 2019).
40. Alyami, S.H.; Rezgui, Y. Sustainable building assessment tool development approach. *Sustain. Cities Soc.* **2012**, *5*, 52–62. [CrossRef]
41. Bernardi, E.; Carlucci, S.; Cornaro, C.; Bohne, R. An analysis of the most adopted rating systems for assessing the environmental impact of buildings. *Sustainability* **2017**, *9*, 1226. [CrossRef]
42. Hallowell, M.R.; Gambatese, J.A. Qualitative research: Application of the Delphi method to CEM research. *J. Constr. Eng. Manag.* **2010**, *136*, 99–107. [CrossRef]
43. Hasson, F.; Keeney, S.; McKenna, H. Research guidelines for the Delphi survey technique. *J. Adv. Nurs.* **2000**, *32*, 1008–1015. [PubMed]
44. Giel, B.; Issa, R.R.A. Framework for evaluating the BIM competencies of facility owners. *J. Manag. Eng.* **2016**, *32*, 04015024. [CrossRef]
45. Skulmolski, G.J.; Hartman, F.T.; Krahn, J. The Delphi method for graduate research. *J. Inf. Technol. Educ. Res.* **2007**, *6*, 1–21.
46. Novakowski, N.; Wellar, B. Using the Delphi technique in normative planning research: Methodological design considerations. *Environ. Plan A* **2008**, *40*, 1485–1500. [CrossRef]
47. Etxeberria, I.A.; Garayar, A.; Sánchez, J.A.C. Development of sustainability reports for farming operations in the Basque Country using the Delphi method. *Revista de Contabilidad* **2015**, *18*, 44–54. [CrossRef]
48. Olawumi, T.O.; Chan, D.W.M. Identifying and prioritizing the benefits of integrating BIM and sustainability practices in construction projects: A Delphi survey of international experts. *Sustain. Cities Soc.* **2018**, *40*, 16–27. [CrossRef]

49. Vagias, W.M. *Likert-Type Scale Response Anchors*; Clemson International Institute for Tourism & Research Development, Department of Parks, Recreation and Tourism Management: Clemson, SC, USA, 2006.
50. Gao, H.; Xu, Y.; Gu, X.; Lin, X.; Zhu, Q. Systematic rationalization approach for multivariate correlated alarms based on interpretive structural modeling and Likert scale. *Chin. J. Chem. Eng.* **2015**, *23*, 1987–1996. [CrossRef]
51. Christie, C.A.; Barela, E. The Delphi technique as a method for increasing inclusion in the evaluation process. *Can. J. Program Eval.* **2005**, *20*, 105–122.
52. Catalina, T.; Virgone, J.; Iordache, V. Study on the impact of the building form on the energy consumption. In Proceedings of the Building Simulation 2011: 12th Conference of International Building Performance Simulation Association, Sydney, Australia, 14–16 November 2011.
53. Lai, W.; Tian, W.; Zuo, J.; Yang, Z.; Liu, Y.L.; Yang, S. Effects of Building Form on Energy Use for Buildings in Cold Climate Regions. *Procedia Eng.* **2016**, *146*, 182–189.
54. Teemusk, A.; Mander, Ü. Green roof potential to reduce temperature fluctuations of a roof membrane: A case study from Estonia. *Build Environ.* **2009**, *44*, 643–650. [CrossRef]
55. Zhang, Q.; Miao, L.; Wang, X.; Liu, D.; Zhu, L.; Zhou, B.; Liu, J. The capacity of greening roof to reduce storm water runoff and pollution. *Lands Urban Plan.* **2015**, *144*, 142–150. [CrossRef]
56. Medl, A.; Stangl, A.; Florineth, F. Vertical greening systems: A review on recent technologies and research advancement. *Build. Environ.* **2017**, *125*, 227–239. [CrossRef]
57. Pérez-Lombard, L.; Ortiz, J.; Pout, C. A review on buildings energy consumption information. *Energy Build.* **2008**, *40*, 394–398. [CrossRef]
58. Karatayev, M.; Clarke, M.L. A review of current energy systems and green energy potential in Kazakhstan. *Renew. Sust. Energy Rev.* **2016**, *55*, 491–504. [CrossRef]
59. EnergyProm Report. 2017. Available online: www.energyprom.kz (accessed on 5 March 2019).
60. Pearce, A.; Ahn, Y.; HanmiGlobal Co Ltd. *Sustainable Buildings and Infrastructure*; Bell & Bain Ltd.: Glasgow, UK, 2012.