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# Factors Influencing Green Building Development in Kazakhstan

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**Abstract:** Green buildings have been actively spreading as a solution for sustainability issues of the construction industry in at least the last two decades. As green building practices unfold in developing countries, the need of identifying factors that both hinder and drive its spread rises. Multiple studies reveal a general inconsistency among results in different parts of the world, caused by each country's environmental, economic, and social conditions. Taking into account the experience of developing international green buildings and the current state of green building development in Kazakhstan, this study aims to spread the understanding of the factors that hinder and have the potential to drive the development of green buildings in Kazakhstan. A questionnaire survey was carried out among 38 industry experts in Kazakhstan to accomplish study objectives. Multiple data analysis methods were used to identify correlations among groups of experts and rank the factors. The results revealed a lack of skill/experience, a lack of government support, and the high cost of sustainable materials and products as the most crucial barriers. Water and energy efficiency, improved health of occupants, comfort, and satisfaction were identified as the most influential drivers. By expanding knowledge on factors affecting the implementation of green buildings, the study uncovered common trends in the responses of professionals, providing valuable information for field professionals and suggesting future research recommendations.

**Keywords:** green buildings; drivers; barriers; funneling technique; PESTLE

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## 1. Introduction

### 1.1. Background

The global building industry has a significant impact on the environment, economy, and society. The construction phase, including material manufacturing, is responsible for 10% and the operation phase of the buildings responsible for another 28% of global $CO_2$ emissions [1]. Essential needs such as heating or cooking require the use of carbon-intensive sources of energy such as oil, gas, and coal, consuming around 60% of the global electricity used just for building operation purposes [1]. The energy consumption of residential and nonresidential buildings takes up to 30%, and the building construction industry represents 5% of global energy use as of 2019 [1]. Statistics represent a steady increase in energy consumption of 7%, with increased total floor area and population in the last nine years [2]. Emission rates related to the construction industry are increasing at a slow but steady pace [2]. Furthermore, the construction industry accounts for up to 40% of the world's materials consumption, almost 30% of the use of timber, and approximately 15% of the total water consumption [3]. On average, 40–60% of all landfill wastes are generated during construction processes [4]. Moreover, the construction industry is a significant contributor to global warming, resource depletion, and air and water pollution, and is the cause of various natural hazards [5–7].

Active measures are taken in the face of sustainable development strategies to diminish the harmful effects of the global building industry. Yudelson [5] defined a green building as a high performance property that reduces its impact on the environment and humans throughout its life cycle. It is intended to use less water and energy. It aims to improve the built environment radically. It considers preserving non-renewable energy sources and promotes renewable sources of energy, advancing the existing technologies and construction methods. Moreover, the green building gravitates toward a healthy environment for the occupants by enhancing indoor air quality and nontoxic materials.

Many countries are successfully implementing green practices, and some are in the process of embracing them. However, despite the rapid growth of the green building concept, numerous impediments prevent its adoption worldwide [8,9]. Moreover, the barriers that prevent the spread of green building vary from country to country. Factors that are more important in one place can be less critical in a different place due to country-specific characteristics such as demography, culture, economy, and location [10,11]. This discrepancy arises from reconsidering and readjusting existing green building practices to the needs and capabilities of the country. There are also risks and uncertainties related to implementing the green building concept that must be investigated [12]. Therefore, it is crucial to identify the drivers and barriers of green building to develop a proper approach for successfully promoting and implementing its practices.

### *1.2. Research Aim and Objectives*

Based on the international experience of factors for green building development, the study considers the current state of Kazakhstan's green building development. This paper aims to spread understanding of the factors that hinder and the factors that can drive green building development in Kazakhstan. Consequently, the following objectives are established:

1. To examine the importance of green buildings in general and for Kazakhstan
2. To identify the factors (barriers and drivers) that influence the development of green buildings.
3. To evaluate the drivers and barriers to green building in Kazakhstan.

The research objectives are organized in a systematic approach called the "funneling technique", effectively utilized in many aspects of questioning, including research [13]. The "funneling technique" idea narrows the general information into practical and operable solutions [13].

The findings of this study will contribute to the existing body of knowledge regarding both green building drivers and barriers in the context of a developing country. In addition, the identified green building barriers and drivers were ranked using the PESTLE technique in order to provide a broader view of the factors. In this regard, the most and least significant factors were shown and ranked in terms of the Political, Economic, Sociocultural, Legal, and Environmental categories, and can be helpful for practitioners intending to take actions in mitigating the barriers of green building technology and using drivers to its adoption. The main novelty of the research is the implementation of the PESTLE method to understand the green building's barriers and drivers.

Additionally, this study can be valuable by expanding knowledge about factors that affect the implementation of green building, providing valuable information for field practitioners, and suggesting future research recommendations.

The paper is structured as follows: The next section presents a review of the literature on green buildings. It provides a summary of the concept of a green building, its drivers, and barriers. Furthermore, the current state of green buildings in Kazakhstan is described in this section. In the third section, an explanation of the four-step methodology of the study is given. The fourth section demonstrates the results, while the fifth section discusses the research results and findings. The last section concludes the research paper.

## 2. Literature Review

### 2.1. Green Buildings

The concept of a green building or sustainable construction is the step of our community toward sustainable development. It is the care for the future and future generations, as sustainability is often interpreted as utilizing resources to meet the needs of the present without compromising the future generations' ability to meet their own needs [14]. Ahn et al. [6] identified the benefits of sustainable construction, dividing them into three main pillars as presented in Table 1.

**Table 1.** Environmental, social, and economic benefits of sustainable construction.

| Environmental Benefits | Social Benefits | Economic Benefits |
|---|---|---|
| • Protecting air, water, and land ecosystems<br>• Conserving Natural Resources<br>• Preserving animal and genetic diversity<br>• Protecting the Biosphere<br>• Using renewable natural resources<br>• Minimizing Waste Production or Disposal<br>• Minimizing $CO_2$ Emissions<br>• Pursuing active recycling<br>• Maintaining the integrity of the environment<br>• Preventing global warming | • Improving the quality of life for individuals and society as a whole<br>• Alleviating poverty<br>• Satisfying human needs<br>• Optimizing social benefits<br>• Improving health, comfort, and well-being<br>• Minimizing cultural disruption<br>• Providing education services<br>• Promoting harmony among human beings and between humanity and nature | • Improving economic growth<br>• Reducing energy consumption and costs<br>• Raising Real Income<br>• Improving productivity<br>• Lowering infrastructure costs<br>• Decreasing environmental damage costs<br>• Reducing water consumption and costs<br>• Decreasing health costs<br>• Decreasing absenteeism in organizations<br>• Improving Return on Investments (ROI) |

It is important to note that sustainable development has limitations. According to Barbier [11], the three pillars of sustainability (environmental, economic, and social) cannot be utilized to their full potential concurrently. The meaning of development must overcome a series of continuous trade-offs, such as the trade-off between increased productivity and the degradation of the environment [11]. Further, the trade-offs are regularly changing due to the intense nature of development and the various ecological, economic, and social conditions [11]. Therefore, sustainable development demands have different levels of importance in other places; they are never constant and change over time. This difference directly applies to the concept of green building as part of sustainable development. Therefore, there is no guarantee that successful practices in one of the ecological, economic, and social dimensions will be similarly effective in other dimensions.

### 2.2. Barriers of Green Building

It is convenient to better use the PESTLE method to understand the factors affecting the development of green buildings, distributing various aspects according to political, economic, sociocultural, technological, legal, and environmental categories (PESTLE). Moreover, the PESTLE method provides a bird's eye view and an organized look at the factors [15].

There are no negative impacts on the environment caused by factors related to green buildings, as the concept of green building is based on minimizing the negative effects on the environment. Therefore, barriers affecting the spread of green buildings can be distributed only among political, economic, sociocultural, technological, and legal categories. Furthermore, the factors that affect the spread of green buildings are very interrelated. Some elements can correlate with several PESTLE categories, such as "lack of market demand", identified as one of the fundamental barriers by Chan et al. [16], which can be underlined in the economic category and partly in the sociocultural category. Market demand can arise from sociocultural circumstances, even mainly being an economic factor. However, factors were classified according to their primary attributes, not their origin, to avoid uncertainties in this study.

*(1) Political barriers.* Lack of governmental support and promotion can be classified as political factors. Chan et al. [16], a Ghanaian professional surveyor, identified the lack of government incentives as one of the top three most critical barriers to the development of green construction, highlighting the role of government as a crucial part.

The promotion of sustainable construction resulted in the advancement of low carbon technologies that reduce the impact on the environment in the construction phase; as pointed out in a study carried out on existing green buildings by Eichholtz et al. [17], a lack of promotion is the cause of the slow spread of green practices.

*(2) Economic barriers.* In many studies, the cost is the most critical barrier to green construction, as it requires more initial investment than traditional buildings [6]. Perception of higher costs causes the market to withdraw from green projects, as noted by Ahn & Pierce [18]. However, studies in the US and UAE show that cost is not the most crucial barrier [12,19].

An extended payback period is another substantial factor in the economic category, delaying the spread of green buildings, and is often ranked as the second most important barrier after cost. According to Lam et al. [20], the additional time required for a green project is a crucial factor affecting stakeholders' decisions on par with higher costs.

Darko et al. [12] also pointed out other barriers such as lack of market demand and risks and uncertainties involved in the implementation of new technologies as crucial factors in the study conducted in the USA.

*(3) Sociocultural barriers.* The literature represents lack of knowledge and awareness as a critical barrier to consider, as some studies suggest resolving it might solve multiple issues at once [9,19]. However, it might require much effort to raise awareness among stakeholders as it is directly tied to government incentives and educational programs [9].

Darko et al. [12] identified resistance to change as the most critical barrier in their study, followed by a lack of the benefits of knowledge and awareness of sustainable construction benefits. Further, the study stated that resistance to change could determine the success of green buildings in the US [12].

*(4) Technological barriers.* An extended construction period is another factor related to time, similar to more extended payback periods that affect the spread of green buildings. However, the underdevelopment of technologies in the area is the leading cause of longer construction periods [20], which puts it in this category. Langdon [20] emphasized that the extended construction period is due to soft costs (additional planning and design).

Furthermore, Darko et al. [12] highlighted other significant factors: a lack of experienced staff, educational programs, databases, and information.

*(5) Legal barriers.* Aktas & Ozorhon [21] emphasized the importance of green building regulation in their study carried out in Turkey. It was one of the factors that affected the decision-making of owners and the top management support. Additionally, Ulubeyli et al. [22] pointed out difficulties in adapting legislation and laws regarding green construction in Turkey.

Green labeling is another critical factor [12,21], as the lack of green building rating certifications can cause difficulties in adopting green projects [12].

### *2.3. Drivers of Green Buildings*

Drivers of green buildings are classified similarly to barriers according to the PESTLE method.

*(1) Political drivers.* As lack of government support can be a critical factor affecting the spread of green buildings [9,16], contrary government incentives towards adopting green buildings can be a determining factor [9,23]. Darko et al. [23] suggested that government support could compensate stakeholders for the additional cost of building green, promoting

green construction. Similarly, Alsanad [9] had drawn the same conclusion examining factors in Kuwait.

Several studies have stated the importance of company image and reputation when choosing green projects [24,25].

*(2) Economic drivers.* The common perception that although green buildings have higher implementation costs, they also possess lower operational costs, reducing overall lifecycle expenses, has driven the market long [23]. Studies in Australia and New Zealand revealed the reduced lifecycle cost of green buildings as the most critical driver [26]. A similar study presented this factor in Ghana in the list of top five most influential factors [27].

Love et al. [28], examining an office building in Australia, pointed out several critical drivers, including the attraction of premium clients and high rental returns. High rental returns, reduced operational costs, and lower turnover variability lead to improved building value, which is itself a significant driver of green buildings [29].

*(3) Sociocultural drivers.* In addition to environmental benefits, green buildings improve the health, comfort, and satisfaction of occupants compared to traditional buildings [30]. It was also rated the second most important factor in Ghana [26]. Moreover, an improved environment for the occupants can attract quality employees [26]. By itself, the attraction of quality employees is an influential driver of green buildings [12].

Unlike lack of awareness being a critical barrier to the spread of green buildings, increased understanding can be a determining driver. Regulations, policies, and educational programs toward green buildings can improve the level of awareness [23].

*(4) Technological drivers.* Green building practices advance conventional technologies, improving the efficiency of construction processes and management practices. Although Darko et al. [10] revealed the low impact of improved construction efficiency as a driver, it is worth considering the improvements green practices provide. In addition, green projects require more technology, and participants are more likely to be in an integrated work environment [31], which brings construction management processes to another level.

*(5) Legal drivers.* Andelin et al. [25] noted that the number of governmental regulations and urban policies is constantly increasing and is expected to increase in the future. Such steps are essential in promoting green practice.

Another crucial factor that affects the spread of green buildings is the rating systems, such as LEED or BREEAM. The findings show that in addition to affecting the decision-making of stakeholders, the green design of the project undergoes changes depending on the requirements of the rating system [32], showing the importance and influence of certification systems.

*(6) Environmental drivers.* A green building is designed to minimize its harm to the environment, efficiently using water and energy resources, and considering human health and comfort [4]. Additionally, green practices encourage reducing construction and demolishing wastes.

Based on an international survey of green building experts carried out by Darko et al. [10], energy and water efficiency were the second and third most important factors driving the adoption of green buildings, respectively. Furthermore, Ulubeyli et al. [22] revealed the importance of Turkey's energy infrastructure and efficiency, ecological sustainability, and waste management. Gathering the environmental benefits of the green concept is tremendous and influential to its spread.

### *2.4. Green Building in Kazakhstan*

Kazakhstan's annual $CO_2$ emissions have increased steadily since 1999, reaching 318 million tons in 2019 [33]. The country's energy consumption in 2019 was around 75 Mtoe (Mega tonnes of oil equivalent), increasing from 55 Mtoe in 2015 [34]. It is important to note that Kazakhstan's economy is profoundly dependent on coal, oil, and gas, having a massive potential in renewable energy in the face of small hydro, solar, wind, geothermal, biomass, and waste recycling [35]. However, coal-based electricity generation was 70%, natural gas 20%, and the other 10% were renewable energy sources (including hydroelectricity) in 2019 [33]. The electricity generated based on renewable energy sources did not grow since 2015 [33]. There was a decline compared to 2016 when renewable energy sources were 12%, and 11% in 2017 [33]. Furthermore, the actual utilization of renewable energy was only 1.4% in 2018 [34].

Energy consumption only in residential buildings was 27%, the 2nd highest after the industrial sector in Kazakhstan as of 2019 [33]. The annual rate of overall floor area increase of residential buildings was around 10% [33]. According to the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, 42,282 buildings were put into operation in 2019, 90% of which are residential [34]. The number of buildings in operation increases annually, with a growth rate ranging from 7 to 20% [34].

Kazakhstan has already taken the first steps toward sustainable development and has set ambitious goals. In 2015, Kazakhstan adopted the 2030 Agenda for Sustainable Development Goals at the UN Headquarters [35]. In 2013, in response to achieving green/sustainable construction goals, the Kazakhstan Green Building Council (KazGBC) was formed. In addition, KazGBC began devising the national certification system for residential buildings in 2017 [36,37]. Nonetheless, there are only 74 green-certified buildings in the country, mainly located in Nur-Sultan and Almaty [8]. They are rated according to BREEAM and LEED certification, and most buildings achieve the lowest acceptable score [8]. Consequently, there are still obstacles to overcome, which arise when identifying barriers and potential drivers to spread green building practices.

## 3. Research Methods

This research investigates the factors that affect the development of green buildings in Kazakhstan. Therefore, a quantitative research method was used to conduct the research, including a literature review, online questionnaire survey, data analysis, and the PESTLE method.

### *3.1. Review Method*

The first step of the literature review was to identify articles based on their titles, abstracts, and keywords in Scopus. The keywords used for the search were "green building", "green construction", and "sustainable construction". The results showed more than 3237 articles related to green buildings with a constant growth rate of around 20% from 2010 to 2020. These numbers represent a significant interest in the area. The next layer of filtering was to add the keywords "barriers" and "drivers" to limit the number of papers according to their relevance to the topic. The final number consisted of 73 papers between 2010 and 2020. Skimming the abstracts allowed verification of around ten articles similar to studies carried out in other countries. Another 21 were identified as eligible for review, as they were closely related to the topic, had a good citation count, and were published in top-tier journals.

Several more articles were identified within the reference list of similar studies dating back to the early 2000s. However, the information from those papers is still relevant, as researchers constantly cite the work up to date. The identified articles were sufficient to cover the first and second objectives of the study. Nevertheless, very few research articles cover Kazakhstan's level of green building development in the Scopus database. Some part of the information was obtained through "The Green Building Information Gateway", "The Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan", and other open source databases.

### *3.2. Questionnaire Survey Preparation*

An online questionnaire survey was conducted to collect professional perceptions of factors affecting the implementation of Kazakhstan's green buildings. A questionnaire survey is a standard method used in similar studies. Additionally, an online questionnaire survey is a time-efficient approach to collecting a massive amount of data without a researcher's presence. Additionally, with the existing variety of questionnaire tools available online, it has become more convenient to use this method. The questionnaire survey was conducted via the Qualtrics web survey tool. The survey was administered from February to March 2021. First, eligible respondents were identified. In this regard, the authors used the Green Building Information Gateway website to find the list of green-certified buildings [8]. Afterward, contractors of the green-certified buildings were found and contacted through phone calls, social networks such as Linkedin, Facebook, and personal visits to the companies' offices. Linkedin, in particular, allowed finding and contacting the experts easily.

Moreover, it was very convenient to have a conversation with the experts and collect their feedback. Multiple experts were also kind by sharing the contacts of their colleagues who contributed to the study. Combined, at least 70 invitations were sent from various sources.

In preparing the survey questionnaire, standard drivers and barriers were compiled through a literature review. A total of 36 barriers and 45 drivers of green buildings were identified. However, it was essential to simplify and refine the list of 81 factors since there were some similar factors (or derivatives from other factors) listed in different studies. Furthermore, the official Qualtrics recommendations on a successful survey state that surveys over 12 min can be tiresome and have low response rates [38]. The entry of the list of 81 factors alongside basic information questions was estimated to take 16 min on average, according to the built-in Qualtrics estimation application. Therefore, a mapping table was used to identify the literature factors' frequency of occurrence to identify their significance [35]. A factor in the list was removed if it had a low occurrence rate and was a derivative of a more significant factor. For example, "average income per capita" was mentioned only once and can be considered as part of the "economic state of the country" factor. However, some factors having a relatively low occurrence rate are still kept in the list, such as the "economic state of the country", due to its importance identified in previous studies [7].

Moreover, "Green building (GB) rating systems" and "difficulties adapting to the certification system" have relatively low occurrence rates. However, they are potentially influential factors due to the lack of a national certification system in Kazakhstan. Therefore, these factors remained on the final list. The final lists of barriers and drivers used for the questionnaire survey are provided in Tables 2 and 3, respectively.

**Table 2.** A compiled list of barriers based on the literature.

| ID | Barriers | Frequency of Occurrence | References |
|---|---|---|---|
| B01 | Lack of government support | 5 | [9,12,16,19,39] |
| B02 | Higher costs of Green building technologies (GBTs) | 9 | [8,9,12,16,19,22,38–40] |
| B03 | Lack of market demand | 2 | [12,16] |
| B04 | Risks and uncertainties involved in implementing new technologies | 6 | [7,8,12,41,42] |
| B05 | Economic state | 2 | [9,22] |
| B06 | Long pay-back periods | 6 | [6,12,16,19,40,41] |
| B07 | Lack of knowledge and awareness of GBTs and their benefits | 8 | [6,9,12,16,19,22,40,41] |
| B08 | Conflicts of interests among various stakeholders in adopting GBTs | 3 | [12,16,41] |
| B09 | Resistance to change | 4 | [9,12,16,21] |
| B10 | Lack of GBTs databases and information | 5 | [12,16,19,21,41] |
| B11 | Lack of reliable GBTs research and education | 5 | [12,16,19,21,41] |
| B12 | Lack of skilled/experienced staff | 8 | [9,12,16,19,22,41,42] |
| B13 | Longer construction period | 4 | [19,22,40,42] |
| B14 | Lack of reliable and available and reliable GBTs suppliers | 7 | [6,12,19,21,22,41,42] |
| B15 | High cost of sustainable materials and products | 5 | [6,21,22,41,42] |
| B16 | Complexity and rigid requirements involved in adopting GBTs | 5 | [12,16,21,41,42] |
| B17 | Fewer GB regulations available | 6 | [9,12,16,22,41,42] |
| B18 | Insufficient GB rating systems and labeling programs available | 3 | [12,16,22] |
| B19 | Difficulties adapting of the certification system | 2 | [22,42] |

Besides asking respondents to rate the factors on a five-point Likert scale, basic information was collected to analyze the results further. The online questionnaire survey contained questions about the company, profession, years of experience of the respondents in the building industry, and whether they have experience in green building projects.

**Table 3.** Compiled list of drivers based on frequency of occurrence.

| ID | Drivers | Frequency of Occurrence | References |
|---|---|---|---|
| D01 | Government support | 7 | [6,9,12,23,31,40,43] |
| D02 | Company image and reputation | 6 | [12,19,21,23,31,43] |
| D03 | Reduced lifecycle costs | 8 | [6,10,12,19,23,31,42,43] |
| D04 | Attract premium clients | 6 | [10,12,22,23,42,43] |
| D05 | High rental returns | 7 | [10,12,19,23,31,42,43] |
| D06 | Improvement in the national economy | 3 | [10,12,43] |
| D07 | Increased building value | 7 | [10,12,19,23,31,42,43] |
| D08 | Improved occupant health, comfort, and satisfaction | 8 | [10,12,19,22,23,31,42,43] |
| D09 | Attract quality employees and reduce employee turnover | 4 | [10,12,23,41] |
| D10 | Facilitation of practice sharing | 4 | [10,12,19,39] |
| D11 | Educational programs | 4 | [6,9,23,39] |
| D12 | Commitment to social responsibility | 5 | [6,10,12,23,42] |
| D13 | Increase of awareness | 4 | [6,22,23,39] |
| D14 | Efficiency in Construction Processes and management practices | 5 | [10,12,23,31,43] |
| D15 | Construction standards/Urban planning policies | 4 | [6,9,12,39] |
| D16 | GB rating systems | 2 | [6,23] |
| D17 | Energy-efficiency | 9 | [6,10,12,19,22,23,31,42,43] |
| D18 | Water-efficiency | 8 | [9,10,12,19,22,23,42,43] |
| D19 | Low environmental impact | 7 | [10,12,19,23,31,42,43] |
| D20 | Better indoor environmental quality | 8 | [9,10,12,21,23,31,42,43] |
| D21 | Reduced construction and demolishing wastes | 8 | [9,10,12,19,22,23,42,43] |
| D22 | Preservation of natural resources | 7 | [9,10,12,22,23,42,43] |

### *3.3. Data Analysis*

Data analysis was performed using descriptive statistics. These statistical methods include: (1) the reliability test using Cronbach's Alpha; (2) the concordance test using Kendall's W; (3) the correlation test using Spearman's rank correlation; and (4) the mean score (M).

Cronbach's Alpha was used to examine the reliability of the collected data, testing internal consistency. Cronbach's Alpha coefficient is based on calculating the average of all possible split-half reliability coefficients ranging from 0 (no internal reliability) to 1 (absolute internal reliability) [44]. Some studies consider a value of 0.6 reliable [45], while some suggest using the rule of thumb, meaning alpha values of 0.8 or higher are acceptable [46]. However, Alpha values above 0.7 are generally considered reliable [9,46]. Cronbach's Alpha coefficient is 0.815 for barriers and 0.895 for drivers, representing acceptable internal consistency and reliability in this study.

Kendall's coefficient of concordance (Kendall's W) represents the level of agreement among raters. The value ranges from 0 (no agreement) to 1 (perfect agreement) [47]. The null hypothesis (H0) for conducted tests is "the distributions of factors are the same". If Kendall's W is low in significance at $p < 0.05$, then the null hypothesis can be rejected, which means that there is no similarity within the distribution of drivers or barriers. Kendall's W is calculated to represent the agreement within different groups of respondents in this study.

The ranking of the mean score is widely used in studies related to green building to classify factors according to their significance [12]. In this study, the mean score ranking identifies the most significant barriers and drivers affecting the spread of green buildings. It is important to note that factors with identical mean scores were sorted according to standard deviation values. Less standard deviation represents higher consistency and, therefore, higher overall rank.

Spearman's rank correlation coefficient was also calculated for different respondents to display the level of association/correlation among their rankings of factors. The coefficient value ranges from −1 to +1, where +1 represents the perfect correlation of rank, 0 no correlation of ranks, and −1 perfect negative correlation. The null hypothesis for this test is that "there is no correlation between groups". Alpha ($\alpha$) is set at 0.05, and if $p < 0.05$, then there is less than a 5% chance that the strength of the correlation occurred by chance; the null hypothesis was confirmed.

The responses were classified into several groups, according to the profiles of the respondents: consultant, contractor, government, and others, according to the type of company: engineer, project manager, consultant, and others, according to the profession, and two groups: experienced and not experienced in green building. Each group was tested on the level of agreement within its respondents using Kendall's concordance coefficient (Kendall's W). Additionally, group responses were ranked and analyzed with the Spearman rank correlation coefficient to represent the association level among various respondents.

## 4. Results

As mentioned earlier, over 70 survey invitations were distributed among practitioners, experts, and academics/researchers. Most of the respondents were local experts, except a couple of foreign professionals who consulted and assisted local green building projects. In total, 38 responses were collected, with a response rate of more than 50%. The results of the survey are described in the following subsections.

### *4.1. Respondents' Demographics*

The majority of the respondents were contractors at 39%, followed by other companies at 21%, consultant companies at 16%, government companies at 13%, financial investment companies at 5%, and material supplier and architect companies at 3% each.

The survey revealed that most respondents were engineers at 40%, consultants and other disciplines at 18%, while 16% were project managers. Minor responses were from academics/researchers at 5% and architects at 3%. According to the survey results, 63% of the respondents had 1–5 years of experience in the construction industry, 26% had more than ten years of experience, and 11% had 6–10 years of experience in the industry.

There were a total of 21 (55%) respondents who claimed to have a green building experience, and 17 (45%) respondents did not have a green building experience (Table 4).

**Table 4.** Respondents' demographic information.

| Company Type | Percentage | Profession | Percentage | Experience in Construction Industry | Percentage | Experience in Green Building | Percentage |
|---|---|---|---|---|---|---|---|
| Contractor | 39 | Engineer | 40 | 1–5 years | 63 | Yes | 55 |
| Other | 21 | Consultant | 18 | 6–10 years | 11 | No | 45 |
| Consultant | 16 | Other | 18 | >10 years | 26 | | |
| Government | 13 | Project manager | 16 | | | | |
| Financial investment | 5 | Academia | 5 | | | | |
| Architect | 3 | Architect | 3 | | | | |
| Material supplier | 3 | | | | | | |

A well-blended response from various participant groups ensures the reliability of the obtained results.

### *4.2. Agreement and Correlations among Respondent Groups*

#### 4.2.1. Company-Type Distribution

The questionnaire survey identified multiple groups of respondents. It is crucial to identify the differences and correlations between these groups.

There are a total of seven groups identified by the survey according to the type of respondents from the company. However, only four groups have a reasonable number of responses for the concordance test. Barrier factors' agreement within the particular group is represented in Table 5.

**Table 5.** Company type related groups and test of concordance for barriers.

| | Consultant | Contractor | Government | Other |
|---|---|---|---|---|
| Kendall's W | 0.277 | 0.074 | 0.304 | 0.172 |
| Chi-Square | 29.884 | 20.110 | 27.383 | 24.838 |
| Degree of Freedom | 18 | 18 | 18 | 18 |
| Asymp. Sig. | 0.039 | 0.327 | 0.072 | 0.129 |

*Barriers.* Kendall's W for the "consultant" group is 0.277, which is considered a low value, representing a low level of agreement. Additionally, asymptotic significance is identified as $p = 0.039$, meaning that the null hypothesis (the distribution of factors are the same) is rejected. Similarly, the "contractor", "government", and "other" groups have a low coefficient of concordance of 0.074, 0.304, and 0.172, respectively. However, the *p*-value is higher than 0.05, therefore retaining the null hypothesis. This result represents the similarity within responses and a nonsignificant level of agreement within these groups.

According to Spearman's rank correlation test of barriers rated by "consultant", "contractor", "government", and "other" groups, we can see a general trend of low correlation among these four groups. Furthermore, the significance level is higher than 0.05, which means that the null hypothesis is retained, and there is no significant correlation among group pairs. The correlation coefficient of the "consultant"–"other" pair is at −0.056, representing a slight negative correlation. However, the correlation coefficient of "contractor" and "government" is at 0.662, generally considered a reasonable association level, with a significance level of 0.002, showing an asymptotic significance.

*Drivers.* Table 6 represents Kendall's W of drivers rated by "consultant", "contractor", "government", and "other" groups. There is generally a low level of agreement within each group, with a significance level greater than 0.05. Therefore, the null hypothesis is retained. On the other hand, the "other" group has a significant level of 0.014, representing a significant difference in agreement.

**Table 6.** Groups related to company type and test of concordance for drivers.

| | Consultant | Contractor | Government | Other |
|---|---|---|---|---|
| Kendall's W | 0.239 | 0.084 | 0.217 | 0.224 |
| Chi-Square | 30.090 | 26.330 | 22.821 | 37.600 |
| Degree Of Freedom | 21 | 21 | 21 | 21 |
| Asymp. Sig. | 0.090 | 0.194 | 0.354 | 0.014 |

The groups' correlation coefficients are reasonable for most pairs, ranging from 0.493 to 0.778 with a significance level lower than 0.05. Only "contractor"–"other" and "consultant"–"contractor" pairs have a low association, with correlation coefficients of 0.177 and 0.261, respectively.

#### 4.2.2. Profession Type Distribution

From the questionnaire survey, respondents can also be categorized according to their profession. Only four of the six categories are used for the agreement test (Kendall's W) and correlation test (Spearman's rank correlation), since other professions had too low responses to be considered for the test. The groups are: "engineer", "project manager", "consultant", and "other".

*Barriers.* Table 7 shows a low level of agreement in each group value ranging from 0.088 to 0.173 with a significance level higher than 0.05. Therefore, the null hypothesis is retained, showing nonsignificant similarities within the responses in each group.

**Table 7.** Groups related to profession types and test of concordance for barriers.

| | Engineer | Project Manager | Consultant | Other |
|---|---|---|---|---|
| Kendall's W | 0.088 | 0.173 | 0.128 | 0.156 |
| Chi-Square | 23.840 | 18.708 | 16.116 | 19.688 |
| Degree Of Freedom | 18 | 18 | 18 | 18 |
| Asymp. Sig. | 0.160 | 0.410 | 0.584 | 0.351 |

Each pair's significance levels in this category exceed the value of 0.05, which means that there are no significant similarities. The correlation coefficient value represents a similar trend showing a low association level, values ranging from 0.106 to 0.396.

*Drivers.* Profession-based groups do not show a significant level of concordance when rating drivers. Kendall's W stays within the range of 0.09 and 0.262, which is considered low. The $p$-value is higher than 0.05 for the "engineer", "project manager", and "other" groups, representing a nonsignificant level of similarity. The "consultant" group has asymptotic significance rejecting the null hypothesis (Table 8).

**Table 8.** Groups related to profession types and test of concordance for drivers.

| | Engineer | Project Manager | Consultant | Other |
|---|---|---|---|---|
| Kendall's W | 0.090 | 0.252 | 0.262 | 0.155 |
| Chi-Square | 28.352 | 31.770 | 38.474 | 22.798 |
| Degree Of Freedom | 21 | 21 | 21 | 21 |
| Asymp. Sig. | 0.130 | 0.062 | 0.011 | 0.355 |

The "consultant"–"other" pair shows a reasonable correlation at a value of 0.673 and a significance level of 0.001 when ranking the drivers. However, other group pairs share a low correlation, with $p$-values higher than 0.05.

### 4.2.3. Green Building Experience-Based Distribution

Responses from two respondents groups based on their experience in the green building were analyzed on the agreement within-group itself and correlation with the other group. Group 1 refers to respondents who have experience in green buildings. Group 2 refers to respondents who do not have experience in green buildings.

*Barriers*. Groups 1 and 2 have a Kendall's W of 0.133 and 0.098, respectively, which is considered low. However, the significance level is lower than 0.05 for both groups, representing asymptotic significance in the results (Table 9). According to Spearman's rank correlation test, Group 1 and Group 2 have a correlation coefficient of 0.274 with a significance of 0.257, which is considered a low association.

**Table 9.** Total mean barriers ranks and two response groups and test of concordance.

| | Total | Group 1 (with Experience in GB) | Group 2 (No Experience in GB) |
|---|---|---|---|
| Kendall's W | 0.081 | 0.133 | 0.098 |
| Chi-Square | 55.364 | 50.108 | 30.074 |
| Degree Of Freedom | 18 | 18 | 18 |
| Asymp. Sig. | 0.000 | 0.000 | 0.037 |

*Drivers.* Kendall's W for Group 1 is 0.142, with a high asymptotic significance level. The null hypothesis is rejected, and there is a significant difference in agreement within Group 1. Group 2 has a significance value of 0.533, meaning there are nonsignificant similarities, in addition to having a similarly low level of agreement with Group 1 (Table 10). It is important to note that the correlation coefficient between Groups 1 and 2 when ranking the driver factors is significantly higher when the same group rated the barriers. The correlation coefficient value is 0.633, with a significant level of 0.002.

**Table 10.** Total mean ranks of drivers and two respondent groups and test of concordance.

| | Total | Group 1 (with Experience in GB) | Group 2 (No Experience in GB) |
|---|---|---|---|
| Kendall's W | 0.085 | 0.142 | 0.055 |
| Chi-Square | 67.863 | 62.811 | 19.812 |
| Degree Of Freedom | 21 | 21 | 21 |
| Asymp. Sig. | 0.000 | 0.000 | 0.533 |

### *4.3. The Final Mean Rank of Factors Categorized According to PESTLE*

The PESTLE method is used to provide a broad view of the factors. The total mean ranks of barriers and drivers are classified according to PESTLE in Tables 11 and 12, respectively. The critical thing to note is that there are some important trends in the factor distributions.

**Table 11.** Mean score with barriers ranks categorized according to PESTLE.

| ID | Rank | Barriers | Mean | SD |
|---|---|---|---|---|
| B12 | 1 | Lack of skilled/experienced staff | 4.11 | 0.831 |
| B01 | 2 | Lack of government support | 4.11 | 0.924 |
| B15 | 3 | High cost of sustainable materials and products | 4.03 | 0.915 |
| B05 | 4 | Economic state | 4.00 | 0.771 |
| B02 | 5 | Higher costs of GBTs | 3.97 | 0.822 |
| B03 | 6 | Lack of market demand | 3.87 | 1.044 |
| B06 | 7 | Long pay-back periods | 3.84 | 1.151 |
| B14 | 8 | Lack of reliable and available and reliable GBTs suppliers | 3.79 | 0.811 |
| B07 | 9 | Lack of knowledge and awareness of GBTs and their benefits | 3.76 | 1.025 |
| B17 | 10 | Fewer GB regulations available | 3.71 | 0.927 |
| B04 | 11 | Risks and uncertainties involved in implementing new technologies | 3.68 | 0.904 |
| B11 | 12 | Lack of reliable GBTs research and education | 3.66 | 0.966 |
| B16 | 13 | Complexity and rigid requirements involved in adopting GBTs | 3.58 | 1.030 |
| B09 | 14 | Resistance to change | 3.50 | 1.109 |
| B19 | 15 | Difficulties in adapting to the certification system | 3.50 | 1.133 |
| B08 | 16 | Conflicts of interests among various stakeholders in adopting GBTs | 3.47 | 1.133 |
| B10 | 17 | Lack of GBTs databases and information | 3.39 | 1.104 |
| B18 | 18 | Sufficient GB rating systems and labeling programs are unavailable | 3.37 | 1.025 |
| B13 | 19 | Longer construction period | 3.24 | 1.025 |

Color Legend

| Political | Economic | Socio-cultural | Technological | Legal |
|---|---|---|---|---|

The results reveal that the three main barriers to green building are:
"Lack of skilled/experienced staff".
"Lack of government support".

"High cost of sustainable materials and products".

According to the respondents, the first most significant barrier is from the Technological category, while other Technological barriers are ranked low. The second most important barrier is the "lack of government support", the only Political factor. The third one is "high cost of sustainable materials and products", followed by other economic factors like "economic state", "higher costs of GBTs", "lack of market demand", and "long payback periods". Therefore, economic factors are found to be more prominent barriers. Sociocultural and legal barriers depict lower rankings than most technological, political, and economic factors.

**Table 12.** Mean score and driver ranks categorized according to PESTLE.

| ID | Rank | Drivers | Mean | SD |
|---|---|---|---|---|
| D18 | 1 | Water-efficiency | 4.61 | 0.790 |
| D17 | 2 | Energy-efficiency | 4.58 | 0.758 |
| D08 | 3 | Improved occupant health, comfort, and satisfaction | 4.55 | 0.686 |
| D19 | 4 | Low environmental impact | 4.47 | 0.797 |
| D22 | 5 | Preservation of natural resources | 4.39 | 0.790 |
| D15 | 6 | Construction standards/Urban planning policies | 4.37 | 0.751 |
| D01 | 7 | Government support | 4.37 | 0.819 |
| D20 | 8 | Better indoor environmental quality | 4.37 | 0.852 |
| D02 | 9 | Positive company image and reputation | 4.29 | 0.835 |
| D03 | 10 | Reduced lifecycle costs | 4.24 | 0.943 |
| D21 | 11 | Reduced construction and demolishing wastes | 4.21 | 1.018 |
| D14 | 12 | Efficiency in Construction Processes and management practices | 4.13 | 0.906 |
| D16 | 13 | GB rating systems | 4.11 | 0.863 |
| D12 | 14 | Commitment to social responsibility | 4.08 | 1.124 |
| D13 | 15 | Increase of awareness | 4.05 | 1.064 |
| D05 | 16 | High rental returns | 4.00 | 1.090 |
| D07 | 17 | Increased building value | 4.00 | 1.090 |
| D10 | 18 | Facilitation of practice sharing | 3.97 | 1.078 |
| D11 | 19 | Educational programs | 3.95 | 1.114 |
| D04 | 20 | Attract premium clients | 3.95 | 1.161 |
| D06 | 21 | Improvement in the national economy | 3.92 | 1.075 |
| D09 | 22 | Attract quality employees and reduce employee turnover | 3.89 | 1.134 |

Color Legend

| Political | Economic | Socio-cultural | Technological | Legal | Environmental |
|---|---|---|---|---|---|

According to the respondents, the top three most significant drivers of green building are:

"Water-efficiency".

"Energy-efficiency".

"Improved occupant health, comfort, and satisfaction of the occupants".

There are some noticeable trends in the drivers' mean score with the ranking list, as four out of the top five most significant drivers are from the Environmental category. The rest of the environmental drivers are also ranked relatively high at 8 and 11, respectively. "Improved health of occupants, comfort, and satisfaction" is the only Sociocultural driver located at the top of the list. The other five sociocultural drivers are contrarily ranked low. Political and Legal drivers are in the middle of the list after the Environmental drivers. The only technological driver, efficiency in construction processes and management practices, is also in the middle of the list and is of lesser importance than environmental, political, and legal drivers. According to experts' responses, it is noticeable that Economic and other Sociocultural drivers are less motivating factors than the rest.

## 5. Discussion

This research sought to identify the barriers and drivers that influence green building development in Kazakhstan. The results from the conducted questionnaire survey were analyzed and validated using descriptive statistics.

### *5.1. Validation of Survey Responses*

Kendall's concordance coefficient revealed a generally low agreement among respondents of the groups, as it did not go over 0.3 for any of the groups. However, this does not necessarily mean that all results are nonsignificant. In multiple cases, the significance level was lower than the probability value of 5% ($p$ = 0.05), representing statistical significance. In cases where the significance level was otherwise exceeding the $p$-value, there is still agreement, but it is considered nonsignificant. It is important to note that more significance is identified among the experienced/inexperienced groups than in company type or profession type groups. There was only one case, agreement within the group with no previous experience in green building rating drivers when the result had a nonsignificant outcome. However, this could be due to a smaller sample size for groups based on company type or profession than experienced and inexperienced groups.

Spearman's rank correlation coefficient tests showed a generally low to medium concordance level among group pairs. There is a noticeable trend within correlation tests when results favor driver factors representing a more consistent medium correlation coefficient with high significance values. The trend is shared for company-type groups, profession-type groups, and experienced and inexperienced groups. The mean values of the driver factors generally have a lower standard deviation. It is more prominent with experienced than inexperienced groups rating driver factors, where the experienced group had a lower standard deviation in the ratings. That is very reasonable as experienced people should have more consistent answers.

As factors were rated according to the Likert scale, statistically, the value of 3 (neither agree nor disagree) is considered neutral. If the mean values of the factors are statistically different from 3, then the result is considered significant. The mean value results showed that the barriers and drivers are different from 3, therefore, significant. However, driver factors have a higher minimum mean value of 3.89, where barrier factors are only 3.24. So, we can assume that the results of the driver factors are more significant than the results of the barrier factors.

*Experienced* vs. *inexperienced groups*. Comparing rankings of experienced and inexperienced groups on barriers revealed a low correlation with the nonsignificant result. We can notice this pattern in multiple rankings, such as for barriers, the experienced group ranked "lack of government support" as 1st (highest importance), and the inexperienced group ranked the same barrier as 15th out of 19. The "economic state" was ranked second by the experienced group and 10th by the inexperienced group. However, the ranks were not negatively correlated as the correlation value was low (0.274) but not zero or negative. The inexperienced group ranked "Lack of skilled/experienced staff", as an example, and the experienced one ranked it 1st, or the "high cost of sustainable materials and products" was ranked 2nd by the inexperienced group and 7th by the experienced one, showing correlation.

On the other hand, the same two groups ranking the driver had a medium level of correlation with a significance level of 0.002. The correlation coefficient between the groups was at 0.633. Notably, both groups ranked "energy efficiency" as the second most influential driver. Further, "improved occupants' health, comfort, and satisfaction" was ranked 1st by inexperienced and 3rd by experienced groups.

Such a difference between the results of barriers and drivers might have been caused by a relatively low sample size when completely different response patterns were used, resulting in a low consistency and correlation or the actual inconsistency in the respondents' knowledge and awareness, meaning respondents are generally less confident about barrier factors. The first theory, reasoning low correlation, and consistency of groups rating barriers being a low sample size seems more reasonable and favoring. However, it also contradicts relatively consistent and statistically significant results of driver factors. Nevertheless, the results for both barriers and drivers are reliable as the calculated Cronbach's Alpha was higher than 0.7.

### 5.2. Mean Scores and Rank

*Barriers.* "Lack of skilled/experienced staff" and "lack of government support" are rated as the first and second most important barriers, both sharing an identical mean value of 4.11. However, "lack of skilled/experienced staff" has a lower standard deviation than "lack of government support". The literature shows similar issues in the UAE [19] and Malaysia [6], where a lack of professionals was identified as similar in importance. This finding makes sense, since Kazakhstan is in its early stages of adopting the concept of green buildings. Therefore, the lack of experienced people in the industry is expected.

The "lack of government support" was rated as the second most important driver in this study. A study in Kuwait [9] identified the importance of government support, suggesting various incentives. Similar cases can be observed in Ghana [26] and Singapore [43], where the lack of government incentives was one of the top three most critical barriers.

The "high cost of sustainable materials and products" was rated as the third most crucial driver. It is closely related to the high cost of GBTs mentioned as critically important in other studies [6,18].

It is an interesting finding that the least influential barriers in this study are "longer construction period" alongside "insufficient GB rating systems and labeling programs available". However, the longer implementation time of green projects was considered one of Australia's most critical barriers [48], and Zhang et al. [40] point out that longer construction times often cause excessive and not attractive payback periods. The reasoning that "longer construction period" is rated low could be, that in general, all existing green-certified projects in Kazakhstan did not face the issue of more extended construction periods.

Although Kazakhstan does not have a national certification system, another low-rated barrier is "insufficient GB rating systems and labeling programs available". This barrier can be related to several successful implementation examples of LEED, BREEAM certifications in recent years. Before 2018, there were no LEED "gold-certified" projects in Kazakhstan, whereas today, there are 7 "gold-certified" buildings [8].

*Drivers.* Professionals rated "water efficiency" as the most important driver, with a mean value of 4.61. "Energy-efficiency" was rated the second most influential factor at a 4.58 mean value, and "improved occupants' health, comfort, and satisfaction" was the third most important factor at 4.55 mean value. All three factors have very similar mean values and low standard deviation values. Studies carried by Darko et al. [12] found these three factors on a similar significance level in the US. "Water-efficiency" alongside "energy-efficiency" were the top two ranked drivers revealed by Darko et al. [12], and the "improved occupants' health, comfort, and satisfaction" was the fourth most crucial driver. There are multiple benefits of green buildings, including reduced lifecycle costs. Around 40% of the reduced lifecycle costs of green buildings can be related to water and energy efficiency [4]. This observation justifies why local experts rated water and energy efficiency as the most significant drivers.

Energy efficiency was the highest-rated driver by Ahn et al. [6] and a similar study in Greece [48], as it is a high priority in many countries [12]. Energy efficiency is one of the most effective, cost-efficient approaches to mitigating climate change and improving air quality [12].

Other significant drivers rated by the respondents include "low environmental impact", "preservation of natural resources", "construction standards/urban planning policies", "government support", which are all commonly known benefits of green buildings.

Drivers like "attract quality employees and reduce employee turnover" and "improvement in the national economy" were ranked low compared to other drivers. However, they represent significant importance, as the mean values are close to 4.00, and their significance was mentioned in other studies [12].

It is hard to say that the highest rated factors in both barriers and drivers are drastically more important than the second or second than the third. However, we can observe trends in the rank distribution of the PESTLE categories. Using PESTLE distribution, we can now state the significance of the Political category. Also, Economic barriers are tightly clustered together, which shows the consistency in respondents' ratings. It shows the viability of using PESTLE analysis to categorize the factors, as it provides another perspective view on existing data and lets us draw interesting conclusions.

## 6. Conclusions

Green building was presented as a solution to multiple environmental, economic, and social problems. It is a progressively developing concept that is spreading throughout the world. However, green building is driven and obstructed by multiple factors that are constantly studied. The study results vary in different places due to the uniqueness of the area and the time the study is carried out, and the development of green buildings must compensate for continuous trade-offs. This study investigates barriers and drivers of green building implementation and their significance with Kazakhstan's perspective through a comprehensive questionnaire survey.

Ranking the barrier and driving factors provides valuable insight for green building implementation in Kazakhstan and suggests the importance of similar studies in other regions. As can be seen from the analysis obtained, the lack of skilled/experienced staff was considered by Kazakhstan professionals the most hindering barrier to green building. A possible reason for the decision of the respondents is that Kazakhstan is at an early stage of green building development, lacking qualified professionals in the area. The same barrier was similarly crucial in other countries such as the UAE and Malaysia.

Water efficiency and energy efficiency were rated as the most influential drivers of green building in Kazakhstan. Green buildings' water and energy efficiency tend to reduce lifecycle costs by around 40%, and they are generally known benefits of green buildings. Furthermore, the country's energy efficiency is considered low due to outdated technologies, which may have affected the respondents' opinions.

The application of PESTLE analysis on the existing data showed significant trends. It is recommended to enhance the analysis by increasing the sample size and normalizing the number of factors for each PESTLE category.

Government plays a vital role in the adoption of green practices, as discussed earlier. Furthermore, the results of the survey revealed that the lack of government support is the second most important barrier. Therefore, it is recommended that the government provide stronger incentives toward sustainable development. In addition, the government could resolve or stimulate the need for experienced employees by providing education programs or encouraging companies to do so. In addition, there is a lack of proper, user-friendly databases to observe the country's current state of sustainability. Information on existing green-certified buildings in the country was obtained through an international database. Obtaining the information in the area should not be difficult. In addition, contacting the experts or finding their contacts was relatively difficult. Although companies cannot publish their employees' personal information in open sources, it is recommended that local companies might provide viable alternatives to contact them as such change might promote more research in the area, advancing it.

Categorizing the responses according to company types and profession types of the respondents revealed valuable information. However, the results were generally nonsignificant, which might have been caused by the relatively low sample size for each category. It is recommended not to conduct a similar analysis due to low correlation among groups or increase the sample size and discover whether the correlation level was heavily affected by the sample size. Analyses of responses from experienced and inexperienced groups in green building revealed statistically significant results. It is recommended to enhance the analysis by increasing the sample size to increase confidence in the results. It is also recommended that the perspective of the owner or the client should also be recorded. In the present survey, this perspective is hidden in categories of company type such as financial investment, government, and others. In this regard, the present paper can be regarded as a precursor to a more comprehensive future study on the topic.

Comparing drivers to barriers results reveals a higher level of confidence among respondents rating the drivers, having higher mean values. Additionally, driver factors results were generally more correlated.

Further investigations are recommended as statistics reveal a relatively low progression level toward the sustainability of Kazakhstan. The results of the study are applicable to field professionals and further investigations in the area.

It is important to conduct a post-use evaluation of the existing green building in Kazakhstan to understand the efficacy of these buildings and the lesson learned. Future study is recommended to investigate the effectiveness and challenges of existing green buildings in Kazakhstan.

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