sustainability

Article

A Partial Least Squares Structural Equation Modelling Analysis of the Primary Barriers to Sustainable Construction in Iran

Saeed Kamranfar [1], Farid Damirchi [2], Mitra Pourvaziri [3], Pardayev Abdunabi Xalikovich [4], Samira Mahmoudkelayeh [3], Reza Moezzi [5] and Amir Vadiee [6,*]

1 Department of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, 20133 Milan, Italy; saeed.kamranfar@polimi.it
2 Construction Engineering and Management, Department of Civil Engineering, Payame Noor University, Tehran 19395-4697, Iran; farid.damirchi@gmail.com
3 Department of Architecture, University of Tehran, Tehran 14395 515, Iran; m_pourvaziri@ut.ac.ir (M.P.); s.mkelaye.91@ut.ac.ir (S.M.)
4 Department of Accounting, Tashkent Institute of Finance, Tashkent 10012, Uzbekistan; pardayev_abdunabi@tfi.uz
5 Association of Talent under Liberty in Technology (TULTECH), 10615 Tallinn, Estonia; reza.moezzi@tultech.eu
6 School of Business, Society and Engineering, Mälardalen University, 721 23 Vasteras, Sweden
* Correspondence: amir.vadiee@mdu.se

Abstract: This paper outlines the obstacles to sustainable construction growth in Iran and thereafter examines the effect and relation between these barriers and the direction of sustainable construction growth as one of the essential objectives for achieving sustainable cities and infrastructure. The study is applied for research purposes that are based on descriptive survey data gathering and correlational data analysis techniques. The statistical population for this study consists of 120 construction-related engineers and university professors who were assessed on a five-point Likert scale. Using SmartPLS software version 4, the responses to the questionnaire were examined. The Kolmogorov–Smirnov assessment was utilized to evaluate the normalcy of the variables, as this assessment is typically employed for this purpose. For data analysis, the PLS (partial least squares) method was used, while SEM (structural equation modeling) methods have been used to assess the study hypotheses. Cronbach's alpha and the composite reliability coefficient (CR) were applied to determine the instrument's viability, and the results show that the coefficient connected to all variables is above 7.0, which is an acceptable value. The AVE (average variance extracted) was also used to evaluate the questionnaire's validity, which was greater than 0.4 and deemed acceptable for coefficients of significance (T-values), coefficient of predictive power (Q2), and coefficient of determination (R2). The obtained results support and confirm all research hypotheses, including that the identified obstacles directly affect the performance of sustainable construction. According to the results of the Friedman test, the legal restrictions variable (CL) is the most significant obstacle to sustainable construction in Iran, with a rank of 4.24. The indicators of political limits (CP) and social and cultural constraints (CSC) came in at second and third, respectively. The results could help government officials make better decisions about where to focus their attention and how to distribute scarce resources.

Keywords: sustainable development; sustainable construction; smartPLS; sustainability barrier

Citation: Kamranfar, S.; Damirchi, F.; Pourvaziri, M.; Abdunabi Xalikovich, P.; Mahmoudkelayeh, S.; Moezzi, R.; Vadiee, A. A Partial Least Squares Structural Equation Modelling Analysis of the Primary Barriers to Sustainable Construction in Iran. *Sustainability* **2023**, *15*, 13762. https://doi.org/10.3390/su151813762

Academic Editor: Manuel Duarte Pinheiro

Received: 10 August 2023
Revised: 29 August 2023
Accepted: 11 September 2023
Published: 15 September 2023

1. Introduction

Population growth and urbanization have resulted in a rise in the popularity of infrastructure projects worldwide [1]. Renewable energy resources are seen as a viable solution for preventing global warming [2]. For instance, achieving a comprehensive understanding of a building's thermal performance is a vital step in the creation of a sustainable structure [3]. Additionally, the construction industry greatly improves the quality of human life [4]. Despite this, it has been noticed that the expansion and advances of the building sector have resulted in several global environmental consequences [5]. According to studies, 30 percent of all carbon dioxide emissions, 40 percent of energy consumption, and 40 percent of solid waste creation are attributable to the construction industry [6]. Therefore, the demand to develop more facilities has exacerbated the poor impacts of the construction sector on human life and global warming [7]. This has prompted governmental and corporate organizations throughout the globe to view the construction industry as one of the nation's key economic development generators [8].

It is essential to collect social, human, economic, and natural capital in order to achieve sustainable development in every country. There are two primary types of sustainable development: strong and weak sustainable development. Strong sustainable development aims to maintain natural capital for future generations, limiting resource use to regeneration rates. Weak sustainable development allows substitution between natural and human-made capital, permitting resource depletion if the overall capital value is sustained or increased [9]. It has been observed that different capitals are somewhat interchangeable due to weak sustainable development. Strong sustainable development, on the other hand, is characterized by limited interchangeability between different capitals because, to achieve strong sustainable development, different capitals are required in order to increase the welfare of present and future generations [10].

It is more appropriate to measure strong sustainable development based on the importance of the different above-mentioned capitals. Developing a sustainable society involves achieving sustainability in all activities requiring resources and the fast and integrated replacement of those resources [11]. The concept of sustainable development, along with economic growth and human development, is concerned with continuous change beyond economic progress [12]. Despite current efforts to achieve green goals, the construction industry is far from reaching its potential. Climate change, along with the growth of construction, is affecting our lives in many ways [13]. Many studies have been conducted in this area, which will be examined in the following cases.

Chan et al. [14] conducted a study in 2018 to identify the greatest barriers to the implementation of green building practices in Ghana's construction sector. The literature study identified 26 obstacles, and a survey questionnaire of forty-three green building specialists was undertaken. The high cost of green building technology, the absence of government incentives, and a lack of funding programs were recognized as the three primary obstacles.

Ametepey et al. [15] undertook an investigation of barriers to sustainable building again in the Ghanaian construction area in 2015. They identified the most probable obstacles to the effective operation of sustainable buildings and classified them by likelihood. The research used a mixed-methods strategy that included a questionnaire and semi-structured interviews. Interviews with 18 contractors and 16 consultants and questionnaire surveys with 100 randomly chosen practitioners were conducted to test the criteria in Ghana. A factor analysis in SPSS Version 16 classified the impediments into six groups. In order of significance, cultural change aversion, lack of government commitment, professional inexperience, concern of higher investment costs, and lack of law are Ghana's major barriers to sustainable building.

An investigation was conducted by Zulu et al. [16] in 2022 to explore factors that contribute to or deter sustainable construction practices in Zambia. In this study, construction professionals and clients were surveyed using an online quantitative questionnaire. Construction firms submitted 112 replies, representing a variety of stakeholder groups. Factor analysis and relative importance indices were used to rank the data.

An analysis conducted by Adabre et al. [17] in 2022 aimed to identify symmetries and asymmetries in the challenges of sustainable housing. Four kinds of hurdles were derived from the current literature: social barriers, economic barriers, institutional barriers, and environmental barriers. A standardized questionnaire was utilized to gather the main data, which was then sent to professionals and home occupants within the Ghanaian housing market using a non-probability, purposive sampling approach.

In 2014, Djokoto et al. [18] investigated the idea of sustainability in the building sector in an effort to identify possible obstacles to sustainable Ghanaian construction. As a consequence, study data were obtained from construction industry experts in Ghana using a questionnaire picked at random. In 2015, Shaikha AlSanad [13] investigated SC (sustainable construction) promotion prospects in Kuwait and the Middle East. This involves assessing the existing SC strategies, the degree of knowledge and awareness of construction investors, the main considerations that encourage green practices, and the hurdles to SC. After a thorough examination of the relevant literature, quantitative methods and a questionnaire were used to gather data. The procedures of judicial sampling and snowball sampling are employed to acquire data, and the findings indicated that the SC idea is not widely implemented in the Kuwaiti construction sector. Therefore, further procedures and tactics are required to enhance and promote this idea so that it may be used successfully in future initiatives.

In 2018, Yin et al. [19] looked at how Singapore's construction industry perceived and understood sustainable building practices and policies. The study was undertaken to investigate the building practices and legislation in the country. They have concluded that government control and encouragement programs can bring beneficial transformation, but this must be accompanied by activities to promote consumer awareness and the adoption of sustainable practices.

Santos et al. [20] conducted a literature evaluation on sustainable construction and building information modeling in 2019 that included a greater variety of environmental, economic, and social variables than earlier research in the area. In recent years, sustainable performance integration literature and building information modeling have increased, indicating that building information modeling is now regarded as a trustworthy technique for construction practices.

Karji et al. [21] explored the sustainable building barriers in the US in 2020 in their research. According to specialists, the first twelve stability hurdles have been investigated in order to reach this objective. Then, 135 industry experts were asked to answer a questionnaire evaluating the relative significance of the elements. PCA was utilized to evaluate the statistics and determine the most important obstacles so that a viable solution could be developed. According to the findings, the most formidable issues confronting the sustainable building sector are pre-construction restrictions, management constraints, planning restrictions, and legal restraints.

An analysis of recent literature was conducted by Hossain et al. [22] in order to identify the concepts, considerations, contributions, and challenges associated with the circular economy in the construction sector. Several challenges have been highlighted in the study, including design, material selection, business model, supply chain, risk and uncertainty, collaboration between actions, understanding knowledge, metropolitan metabolism, relevant policy, and methodological challenges. Regarding the assessment of circular economics, this study showed that the implementation of circular economics in a specific case with full-scale assessment has not yet been performed, and a comprehensive framework for integrating circular economics and methods has not yet been developed. Studies show that helping to install a circular economy in the industry helps to promote sustainable construction.

Siogo et al. [23] published their paper in 2020 to (a) comprehensively describe the concept of TBL as applied to establish the current state of research and to define sustainable construction (b) incorporate TBL framework that will aid in the improvement of sustainability measures. The findings demonstrate the increased awareness and interest in TBL research. On the basis of current developments, the difficulties and drivers of sustainable building and TBL have been studied and explored. The suggested framework incorporates the TBL principles and allows for new theoretical and practical solutions to enhance the construction industry's sustainable integration.

Nasereddin et al. [24] analyzed investment obstacles to sustainable building in 2021 in their research. A framework and three supporting procedures have been designed to combine ideas and sustainable building procedures, assets management, and overall quality assurance in order to enhance project management comprehension and decision making. The data-gathering process consisted of three phases: focus groups (23 contributors), the Delphi approach (two rounds with eight people), and an endorsement survey (20 participants). Their findings indicate that Jordanian LEED silver-certified buildings cost 20–25% extra to build.

Oke et al. [25] evaluated the implementation of a cloud platform and its CSF (critical success factor) in 2021 to ensure sustainable construction projects in Nigeria. Using RII (relative importance rating) and EFA (exploratory factor analysis), 104 construction professionals assessed cloud computing CSFs. Ninety-six percent of respondents are familiar with the term "cloud computing", according to the study's findings. As a consequence of this research, cloud computing may be used to improve the efficiency and longevity of building projects.

Sadeghi et al. [26] assessed the relevance of the highlighted problems and constraints from a sustainability standpoint in 2021. In order to accomplish the study objective, they used the sequential priority (OPA) method for a number of attribute decisions (MADM). This innovative technique calculates the mass of stability qualities and barriers. The findings indicate that DLT adoption requires (1) data management infrastructure, (2) sophisticated applications and archetypes, (3) consumer demand, interest, and direction, and (4) taxes and reporting. Social sustainability depends on resolving the following issues: transparency, supply chain management, anti-corruption, integrity in business rivalry, and anti-counterfeiting.

Iqbal et al. [27] investigated the identification of hurdles to energy management methods in the Pakistani construction industry in 2021. Using the fuzzy Delphi (FDM) approach, barriers identified in prior research were evaluated. These obstacles were then evaluated using the ISM. Kamranfar et al. [28] undertook a study in 2022 to assess the obstacles to the construction of green buildings in Tehran. Using the Delphi technique, the obstacles were identified, and then rated using the DANP model. According to Joshua [29], various obstacles would impede the application of sustainable building procedures by project management teams in 2022. Some of these issues include a shortage of trained personnel, a lack of expertise with green technology, and the higher up-front costs associated with using green building techniques and materials.

The studies cited suggest that the building sector is a long way from reaching green objectives and sustainable construction with existing sustainability practices. Therefore, this research proposes the SmartPLS technique to identify and rank the obstacles to green building. So far, no research has been conducted on the identification of sustainable construction barriers and their ranking in Iran. So, based on the number of identification indicators, a questionnaire was prepared to be presented to the target community. The prepared questionnaire contains general concepts and indicators identified in the study areas and seeks to assess the importance of the most important barriers to green buildings. In this questionnaire, a Likert scale of five has been used. The important responses were categorized as low, medium, high, very high, and extremely high since the research classifies and finds the most important answers. This classification helps make decision making more accurate. In the statistical community under study, 18 senior project managers, 37 design engineers, 18 workshop supervisors, and 47 contractors have been selected due to the specialization of the subject matter.

Section 2 provides exhaustive explanations of the research strategy and analytical methods; it also provides an in-depth examination of the questionnaires and an elucidation of the respondents' comments. The study's findings, together with accompanying discussion and commentary, are provided in Section 3, and its conclusions are discussed in Section 4.

2. Materials and Methods

One of the main parts of any scientific research is data gathering and analysis to test the hypotheses expressed by the researcher [30]. Choosing an appropriate research method helps the researcher to a great extent in preventing mistakes. The use of appropriate statistical tests with the research method leads to ensuring the correctness and exactness of the obtained results [31].

In this section, we will first examine details about the respondents' demographics who cooperated in the research and completed the questionnaire. In the demographic information section, the general information of the respondents will be examined separately. Then, the measurement model for construct validity is presented, and divergent validity is also examined. Using PLS-based regression analysis, the links between the research variables and the primary research model are examined in the following sections. The statistical population's raw data were evaluated using relevant statistical methods and SPSS and SmartPLS software and then processed and provided in the form of information.

2.1. Demographic Characteristics of Society

Descriptive statistical indicators have been used to check details about the respondents' demographics. The frequency of the respondents has been investigated, and the related graphs have been drawn. In the studied statistical community, 18 senior project managers, 37 design engineers, 18 workshop supervisors, and 47 contractors have been purposefully selected according to the specialization of the subject under study. Descriptive statistics indicators have been used to check the details about the respondents' demographics, and the frequency of the respondents has been examined in Table 1.

Table 1. Details about the respondents' demographics.

Job	Frequency	Percentage	Cumulative Frequency
Project manager	18	15.00	15.00
Design engineer	37	30.83	45.83
Site Manager	18	15.00	60.83
Contractors	47	39.17	100.00
All	120	100	

If the data distribution is normal, inferential statistical tests can be used. To examine the normality of the data, the null hypothesis is predicated on the normality of the data distribution. This test is examined with a 5% error. If the probability of greater financial progress is equal to a 5% margin of error, there will be no evidence to contradict the null hypothesis [5].

2.2. Identification of Obstacles

In this study, several obstacles to green building and sustainable construction are retrieved from prior research and considered. Then, by designing a questionnaire in which the main indicators listed in Table 1 are embedded, the opinions of the elites were collected in the form of yes or no. A review of the relevant literature reveals that, although there are certain universal challenges to green building, each location also has its own set of peculiar difficulties. Furthermore, each country has its own set of legislation, economic standing, and degree of environmental realization. After identifying possible obstacles and extracting them from previous research, obstacles have been screened using a questionnaire. Then, a questionnaire consisting of 25 main obstacles and posing the question of whether these obstacles are among the obstacles to sustainable construction in the case study of this research. Furthermore, incorporating the viewpoints of people utilized in the development of this questionnaire (30 academicians and building contractors filled out the initial questionnaire in the first round), repetitive indicators, insignificant indicators, and low indicators of importance are removed, and the final criteria are identified (Table 2).

Table 2. The main obstacles identified.

No.	Barriers
1	Inadequate knowledge of contractors and specialized operators of green and sustainable buildings
2	The cheapness of energy due to allocating subsidies to it
3	Absence of mandated, defined requirements for developing a green building
4	Failing to inform and educate the public on the severe effects of climate change
5	Lack of sufficient knowledge of designers
6	Lack of demand or low demand for green buildings
7	Lack of advertising for green buildings
8	The lack of a single trustee in the field of optimizing energy consumption and the environment
9	Dependence on the budget of institutions related to the sale of renewable materials (conflict of interest of institutions)
10	Funding municipalities from environmental violations in different sectors
11	Inefficiency and demonstration of green designs and buildings
12	Lack of leading companies in the production of materials and green and sustainable technology
13	Risk aversion of domestic and foreign private sector investment
14	Lack of policy for the development of renewable and sustainable energy
15	The low quality of the design and construction of existing green designs
16	Tension in the country's foreign policies and foreign sanctions
17	Uncontrollable inflation of the construction industry in Iran
18	Void of policy making and planning (multiplicity and inconsistencies of law-making institutions)
19	Lack of green and sustainable business plan and financial losses due to lack of experience and planning
20	Lack or poor management of waste and material recycling
21	Lack of sufficient manufacturing technology
22	Lack of legal framework to encourage investment
23	Lack of manpower training in standardization and maintenance of green buildings
24	Immature green materials market
25	Lack of knowledge and awareness of the existing situation by the beneficiaries

2.3. Questionnaire Design and Data Collection

In the third step, the second questionnaire, which was developed from the final findings of the survey and acts as the major survey of the study, was prepared. The second questionnaire was issued online to 250 experts, and the criteria were then rated after the questionnaires were collected (Table 3).

Table 3. Classification of the final obstacles identified in the development of sustainable construction.

	Symbol	Obstacles	Description
1	CKT (Construction—Knowledge and Technology)	Restriction related to knowledge and Technology	Inadequate knowledge of designers, contractors and specialized implementers of green and sustainable buildings
			Lack of leading companies in the production of materials and green and sustainable technology
			Lack of information and awareness about the operation, maintenance, repair, and rebuilding of green buildings
			Insufficient training of personnel in the area of sustainable building
2	CSC (Construction—Social Cultural)	Social cultural restrictions	People's denial of the severe effects of climate change
			No or low demand for green buildings
			Lack of non-governmental organizations (NGOs)
3	CEI (Construction—Economic and Investment)	Economic and investment restrictions	Risk of investment
			The conflict of interests of institutions with the development of green construction (Gaining income of the Ministry of Oil and Energy from sales Energy and municipalities and the environment from crimes)
			High initial cost
4	CMM (Construction—Management and Marketing)	Restriction of management and marketing	Lack of advertising and proper marketing for green buildings
			Lack of cooperation and partnership between organizations Related (engineering system, environmental organization and municipality)
			Lack of roadmap and long-term planning in relation to green construction
			Lack of circular economy system approach instead of traditional linear economy approach (3R = Reduce, Recycle, Reuse)
			Insufficient knowledge of how green construction performs in relation to regional weather and geography
5	CP (Construction—Political)	Political restrictions	Sanctions
			Political instability
6	CL (Construction—Legalisation)	Legal restriction	Absence of statutory standards for constructing green building
			Inadequate government assistance for the creation of environmentally friendly buildings
			Lack of proper policy to prevent waste of water and energy
			Lack of incentives and punishments for Green construction
			Absence of local criteria and framework for regular review of sustainable building

2.4. Analyze Data

In this section, data analysis has been performed in two separate and related parts. First, using demographic variables and frequency tables, the statistical sample of the study is described, and then the main variables of the research are described using the most important descriptive statistics indicators (trend centrality, dispersion, and distribution shape). In the second step, which tests the hypotheses using structural equation modeling, the assumptions are tested.

2.4.1. Step 1: Statistical Description of Research Variables

The standard deviation is used to determine the reliability coefficient in statistical analysis. In scientific studies, data with a standard deviation greater than two are considered outliers and are excluded from the analysis. Although the standard deviation value is usually low or high, it is checked in comparison between different groups to find meaning and is not evaluated alone.

2.4.2. Step 2: Examining the Assumptions of Structural Equation Modeling (Component-Oriented)

Smart-PLS software is best used when the researcher wants to predict the latent (hidden) model variables or figure out how they are related (for example, in the early stages of theory development) [32]. It should be noted that the use of this approach, that is, the partial least squares (PLS) approach, does not need to comply with special assumptions such as the normal distribution of data, their measurement scale, and having a large volume of samples [33]. However, before we use structural equation modeling, we check issues like normality, sampling adequacy, etc., because this assumption is important for both first-generation structural equation modeling (Amos) and second-generation structural equation modeling (partial least squares (PLS)) [34].

2.4.3. Step 3: Checking Sampling Adequacy

KMO Criterion and Bartlett's Test

To ensure the adequacy of the collected sample, two criteria, KMO and Bartlett's test, are used [35]. The optimal limit for the KMO test is greater than or equal to 0.6, and in fact, these results show whether the collected data is sufficient for the intended analysis or not [36].

Kolmogorov–Smirnov Test

Another test used in this research is the Kolmogorov–Smirnov test, which is used to determine whether he should use parametric or non-parametric tests in this research [37]. In other words, the Kolmogorov–Smirnov test shows the non-normality of the data distribution [38]. Notably, if the Kolmogorov–Smirnov test is refused, the data follow a normal distribution; hence, the parametric tests may be performed to analyze them. In contrast, if the Kolmogorov–Smirnov test is positive, it means the data are not normally distributed; hence, non-parametric tests should be used in the study.

Now, to make sure the data here are normally distributed, the mini-zero assumption that the data distribution is normal has been considered at an error level of 0.05. If a significant result is produced that is larger than or equal to the error level (5 percent), there will be no cause to rule out the possibility that the null hypothesis is correct. In other words, the data will be distributed normally.

The following statistical assumptions are used for the normalcy test:

The data for all the variables follow a normal distribution (H0).
Each variable's data do not follow a normal distribution (H1).

2.4.4. Step 4: Model-Fitting Measurements

The research tool validated via model fit, which is a questionnaire in this study, can achieve the goal of the researcher. Convergent validity, instrument reliability, and divergent validity were used to evaluate the adequacy of the measurement model, which included three criteria: composite reliability, Cronbach's alpha coefficients, and factor loading coefficients [39].

Composite Reliability, Cronbach's Alpha, and Convergent Validity

Cronbach's alpha is a traditional dependability metric with deep roots in structural equation modeling. It provides a confidence interval for the reliability of indicators based on their internal correlation; Cronbach's alpha values over 0.7 are generally considered reliable [40]. The PLS method uses composite reliability, a more modern criteria for determining structural dependability than Cronbach's alpha (CR). Composite reliability is preferred over Cronbach's alpha because it takes into account the correlation between the structures rather than relying on an absolute measure of reliability. For the computation of composite reliability, indications with a high factor loading are crucial. The criteria value for the suitability of composite dependability is greater than 0.70. In this study, both of these criteria were employed to assess dependability more precisely. Another criterion used in structural equation modeling to match the measurement model is convergent validity (AVE) [41]. The degree of connection between a structure and its indicators is reflected by convergent validity; the stronger the correlation, the better the match. Fornell and Larker (1981) established the AVE (average variance extracted) criteria to quantify convergent validity and said when the AVE is more than 0.5, convergent validity is satisfactory [42].

Assessing the Divergent Validity and Factor Loadings of the Observed Variables

Determining factor loadings involves calculating the correlation between the structure's indicators and the structure. Fornell and Larcker's criteria were used to assess the reliability of the measurement scheme. If the AVE of a construct is higher than the variance it shares with any other constructs in the model, then the model may be said to have divergent validity. In PLS, this is investigated using a matrix that includes the square root of AVE values for each construct as well as the values of correlation coefficients between them [43].

2.4.5. Step 5: Fitting the Structural Model

Coefficients of Significance (T-Values), Coefficient of Predictive Power (Q2), and Coefficient of Determination (R2)

Once the measurement models' fits have been evaluated, the study's structural model may be fitted. The fit of the structural model demonstrates that the shown model and its linkages are valid and may be used for prediction. Three criteria were utilized in this study: significant coefficients (T-values), predictive power coefficients (Q2), and determination coefficients (R2).

Path coefficient and significance (T-values): The path coefficient and significance is the first and most fundamental requirement for structural model fit. Significant coefficients must have a value equal to or greater than 1.96, the significance index. If the value of these values surpasses 1.96, it shows that the link between the constructs is valid and, consequently, that the study hypotheses have been confirmed [44].

Predictive Power Coefficient (Q2): Predictive ability is also established by the Q2 criteria, which shows poor, medium, and high ability to forecast the linked exogenous variable if it reaches values of 0.02, 0.15, and 0.35 for an endogenous structure, respectively [45].

R2 coefficients of hidden variables: R2 is a measure of the extent to which an exogenous variable affects an endogenous one; values of 0.19, 0.33, and 0.67 are often considered minimum, medium, and high, respectively [46]. The coefficient of determination (R2) reveals the extent to which the independent variable can account for variations in the dependent variable.

2.4.6. Step 6: General Model Desirability

The fit criteria were then applied to evaluate the total research model, and its calculation is as follows: weak, medium, and strong values for goodness of fit are presented as 0.01, 0.25, and 0.36, respectively [47].

$$\mathrm{GOF} = \sqrt[2]{R^2_{Average} \times AVE_{Average}} \quad (1)$$

2.4.7. Step 7: Examining the Intensity of the Relationship Effects of the Research Model

The significance of the correlations between the variables is analyzed after the measurement models, structural model, and general model have all been checked for a good match by the method of path analysis in two steps: the first step is to check the significant coefficients related to the path of each relationship, which is carried out using the Bootstrapping command, and the second step is to verify the connection standardized path coefficients, which is undertaken using the PLS Algorithm command [48].

2.4.8. Step 8: Friedman's Test

After examining the structural equation modeling, it is time to use the Friedman test to rank the research variables. In this section, the researcher intends to use the Friedman test to measure the importance of each variable from the respondents' point of view [49]. In fact, the Friedman test determines whether the sums of the ranks are significantly different from each other or not.

$$Q = \frac{12}{nk\,(k+1)} \cdot \sum_{j=1}^{k} RJ^2 - 3n(k+1) \qquad (2)$$

In this Function:

n: population size (rows)
k: quantity of groups (columns)
RJ: The sum of the ranks in the J-th column.

3. Results and Discussion

Regarding the statistical description of research variables, as is possible to see in Table 4, the average of all dimensions of the research variables is above the average level, and according to the subjects, the CP variable (4.083) has the highest average score, and the CEI variable (3.683) has the lowest average score.

Table 4. Descriptive indices of central tendency and dispersion of research variables.

Dimensions	No. Questions	Average	Standard Deviation
CKT	4	3.958	0.597
CSC	3	3.880	1.020
CEI	3	3.683	0.97
CL	5	4.011	0.866
CP	2	4.083	0.882
CMM	5	3.753	0.961
SCBS (Sustainable Construction Barriers)	1	4.266	1.135

According to the Likert scoring range of 1 to 5 in this research, the obtained standard deviation values seem favorable, and this index is confirmed for all research variables.

3.1. *Adequacy of Sampling*

In order to ensure the adequacy of the collected sample, two criteria, Bartlett's test and KMO, have been used, and the outcomes obtained from these two tests are described in Table 5.

The optimal limit for the KMO test is greater than or equal to 0.6, and according to the results obtained in Tables 2–4, these two tests are approved for all aspects of the research. In fact, these findings validate the viability of using structural equation modeling on the available data.

Table 5. The results of sampling adequacy examination using KMO and Bartlett tests.

Dimension	KMO Test	Bartlett's Test
CKT	0.692	Sig = 0.000
CSC		
CEI		
CL		
CP		
CMM		
SCBS		

3.2. *Kolmogorov–Smirnov Test*

According to the above, Table 6 displays the outcomes of the Kolmogorov–Smirnov test.

Table 6. Statistical analysis using the Kolmogorov–Smirnov test.

Dimensions	Kolmogorov–Smirnov	Significance Level
CKT	1.885	0.002
CSC	2.057	0.000
CEI	1.726	0.005
CL	1.482	0.025
CP	3.085	0.000
CMM	1.308	0.065
SCBS	3.824	0.000

Results from the Kolmogorov–Smirnov test for the study variables' scores indicate that they do not follow a normal distribution; as a result, structural equation modeling using PLS Smart software is appropriate.

3.3. *Convergent Validity, Composite Reliability, and Cronbach's Alpha*

Table 7 shows that Cronbach's alpha value and composite reliability for all seven research variables are both greater than 0.7. This means that the reliability is good, and convergent validity values for the variables that are greater than 0.5 also show that the variables in this study are valid. We may conclude in this part that the research questionnaire is valid and can be used to assess the state of the research variables.

Table 7. Research variables' convergent validity, composite reliability, and Cronbach's alpha.

Hidden Variables	Cronbach's Alpha Coefficients (Alpha $\geq$ 0.7)	Composite Reliability Coefficient (CR $\geq$ 0.7)	Mean Variance Extracted (AVE $\geq$ 0.5)
CEI	0.794	0.880	0.711
CKT	0.700	0.770	0.500
CL	0.859	0.899	0.643
CMM	0.882	0.914	0.683
CP	0.711	0.873	0.775
CSC	0.853	0.912	0.775
SCBS	1.000	1.000	1.000

3.4. Assessing the Divergent Validity and Factor Loadings of the Observed Variables

The computation was performed in order to evaluate the factor loadings and divergent validity of the observed variables, and the results are shown in Table 8.

Table 8. Factor loads.

Latent Variables	Manifest Variables	Factor Loadings	t-Value
CKT	Q1	0.456	2.301
	Q2	0.870	34.299
	Q3	0.580	4.198
	Q4	0.759	10.945
CSC	Q5	0.822	20.840
	Q6	0.914	69.143
	Q7	0.902	39.697
CEI	Q8	0.887	31.139
	Q9	0.849	11.914
	Q10	0.739	53.724
CL	Q11	0.895	65.598
	Q12	0.841	17.366
	Q13	0.798	30.191
	Q14	0.634	6.324
	Q15	0.817	14.253
CP	Q16	0.684	22.688
	Q17	0.897	37.026
CMM	Q18	0.866	35.500
	Q19	0.882	30.734
	Q20	0.809	19.667
	Q21	0.685	10.570
	Q22	0.873	61.291
SCBS	Q23	1.000	0.000

In this study, factor loadings greater than 0.4 indicate the validity of this threshold for determining model fit (Table 8).

Table 9 shows that the correlation value, which is in the bottom and right homes of the main diameter of the matrix, is greater than the root value of the AVE variables in the current study, which is in the homes on the main diagonal of the matrix. Since the constructs (the latent variables) interact more strongly with their indicators than with other constructs, it is safe to say that the model's divergent validity was good in this study.

3.5. The Criterion of Coefficient of Significance (T-Values), Determination Coefficient (R2) and Predictiveness Coefficient (Q2)

The first and most fundamental criterion for structural model fit is the path coefficient of significance (T-values). Coefficients considered to be significant must have a value that is larger than or equal to 1.96, which is the significance index. If the sum of these figures is more than 1.96, then the assumptions have been confirmed, and the link between the constructs is valid. Figure 1 displays the path coefficients of the actual model, and Figure 2 illustrates the relevance of these values.

Table 9. Correlation between latent variables and AVE values.

Structure	CEI	CKT	CL	CMM	CP	CSC	SCBS
CEI	0.834						
CKT	0.559	0.685					
CL	0.759	0.523	0.802				
CMM	0.771	0.600	0.796	0.826			
CP	0.617	0.534	0.750	0.734	0.880		
CSC	0.798	0.604	0.789	0.669	0.749	0.880	
SCBS	0.773	0.671	0.595	0.774	0.647	0.707	1.000

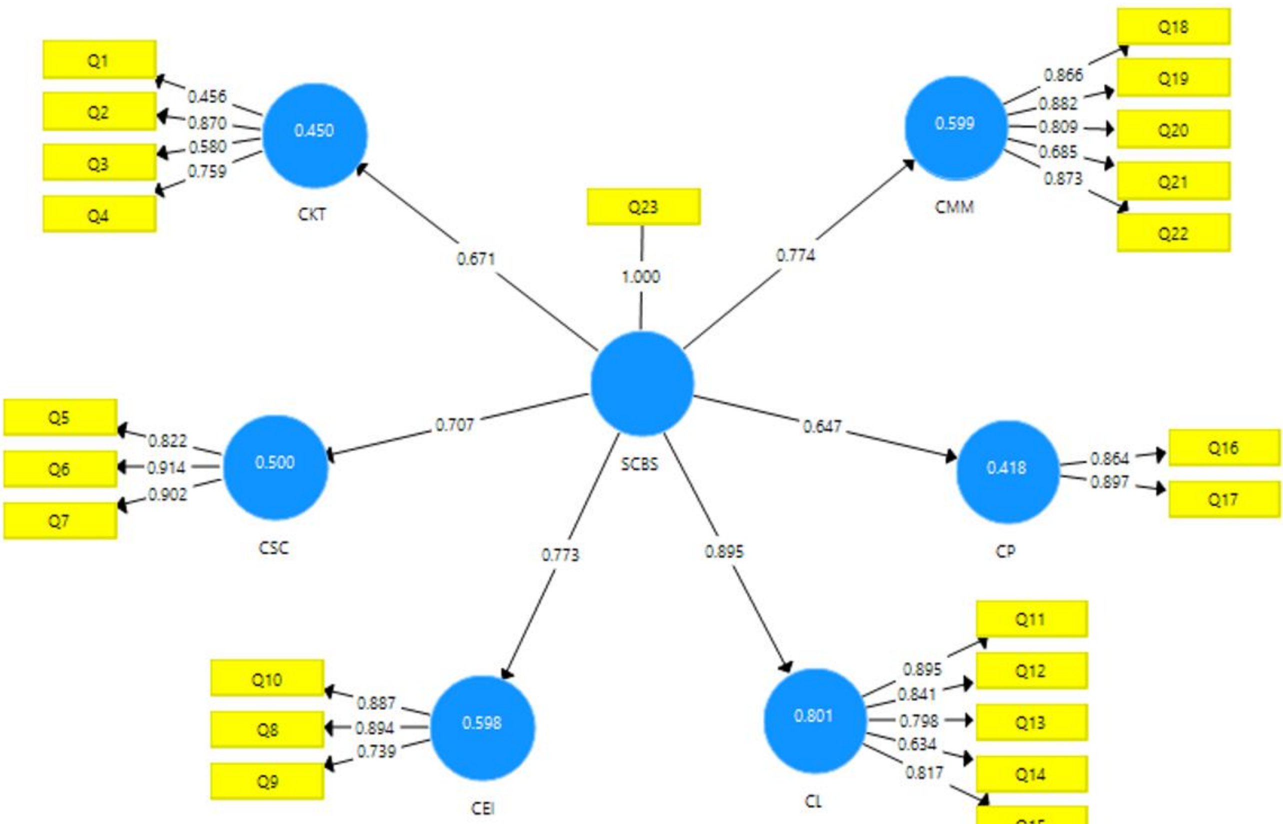

Figure 1. Path coefficient and structural model fit using R2 values.

Exogenous factors in the model have a large impact on the study's endogenous variables, as seen in Figure 1.

All of the associations between the variables in the study model are significant at the 0.99 level of confidence, as shown by the significant coefficients in Figure 2. That is to say, every hypothesized connection between model factors has been verified.

The percentage of variation in the dependent variable that can be accounted for by the independent variable is represented by the value of R2. Table 10 displays the R2 values for the study's independent variables.

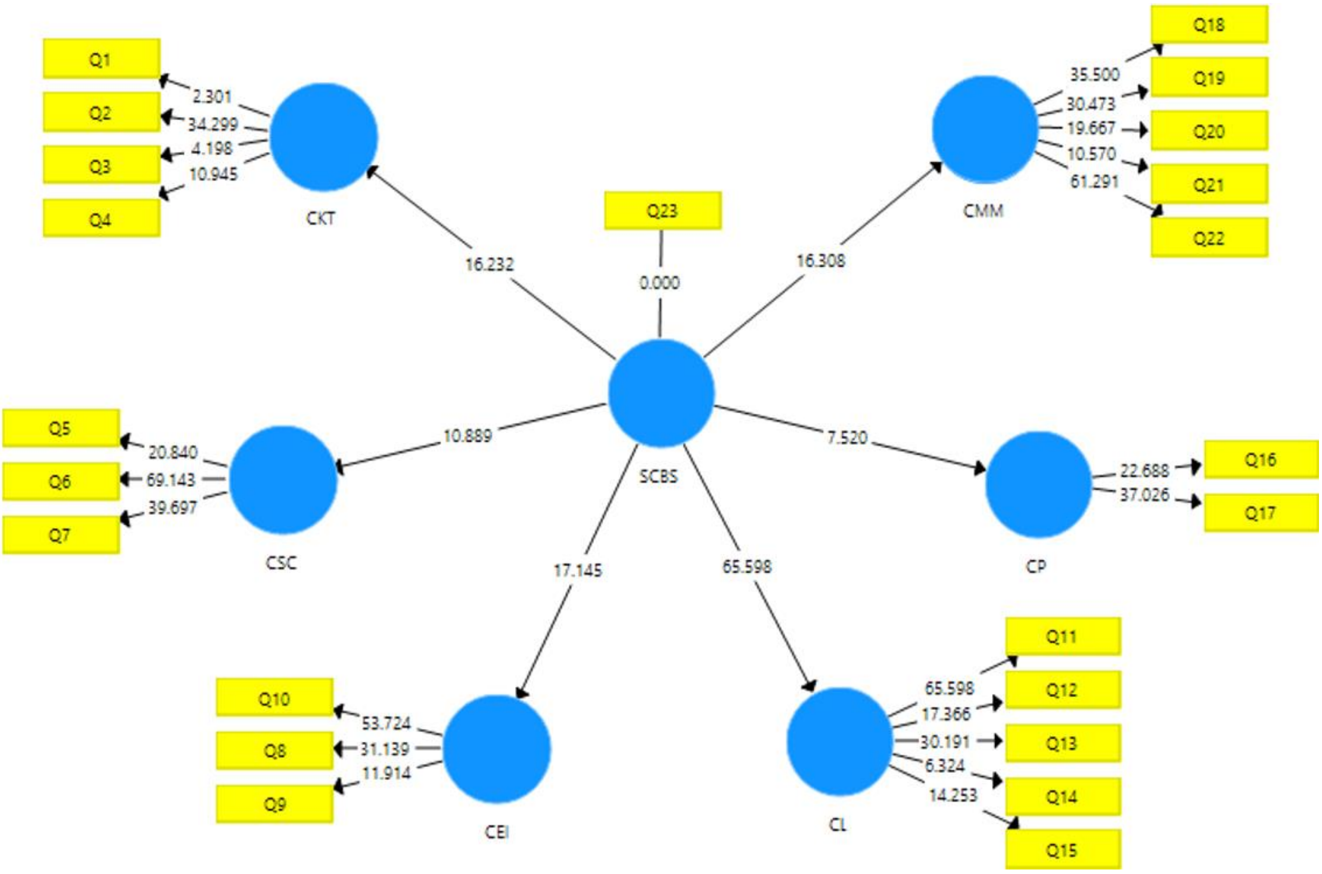

Figure 2. T-value significance coefficients were used to fit the structural model.

Table 10. Values (R2) of research dimensions.

Row	Dimensions	Values (R2)
1	CEI	0.598
2	CKT	0.450
3	CL	0.801
4	CMM	0.599
5	CP	0.418
6	CSC	0.500

Table 10 shows that when the three criteria values are used to assess R2, the value of R2 for the research variables is judged to be high. That is, for example, the CEI variable predicts 59.8% of the SCBS variable.

Table 11 shows that when the three criteria values are compared, Q2 is regarded as having a high level for the research variables. In reality, the value of Q2 demonstrates that the hypotheses are validated since the links between the constructs are well-defined, and the constructs will be able to have an adequate influence on each other's indicators.

Table 11. Values (Q2) of research dimensions.

Row	Dimension	Values (Q2)
1	CEI	0.407
2	CKT	0.181
3	CL	0.455
4	CMM	0.504
5	CP	0.304
6	CSC	0.498

3.6. The Desirability of the General Model

The GOF criteria score of 0.638 percent indicates a very decent match for the whole study model. Therefore, the research model is authorized due to its high level of prediction capacity. The accuracy of the whole research model is evaluated using this index, which is calculated using two fit indices, one for the measurements and one for the structural model. The mathematical definition of GOF is given in the following equation.

$$\text{GOF} = \sqrt[2]{R^2_{Average} \times AVE_{Average}} \approx 0.638189 \tag{3}$$

3.7. Analysis of the Study Model's Impact on the Strength of the Connection

The data presented in Table 12 suggest that the significant coefficients at the 95% confidence level have been confirmed for all relationships [50], and the results indicate a direct relationship between SCBS and all research variables. A detailed description of each relationship, according to Table 12, is given as follows.

The findings of the correlation and regression analyses are shown in Table 12.

Table 12. Examining research hypotheses.

Relationships between Variables		Direct Effects	
Relationship 1		SCBS ← CKT	
Path coefficient: 0.671	Significance coefficient: 16.232	Relationship type: direct	Result: approved
Relationship 2		SCBS ← CSC	
Path coefficient: 0.707	Significance coefficient: 10.889	Relationship type: direct	Result: approved
Relationship 3		SCBS ← CEI	
Path coefficient: 0.773	Significance coefficient: 17.145	Relationship type: direct	Result: approved
Relationship 4		SCBS ← CL	
Path coefficient: 0.895	Significance coefficient: 65.598	Relationship type: direct	Result: approved
Relationship 5		SCBS ← CP	
Path coefficient: 0.647	Significance coefficient: 7.520	Relationship type: direct	Result: approved
Relationship 6		SCBS ← CMM	
Path coefficient: 0.774	Significance coefficient: 16.308	Relationship type: direct	Result: approved

Regarding the first relationship, one might draw the conclusion that the path coefficient between the variables of this relationship is 0.671. That is, the variable of limitations related to knowledge and technology (CKT) (67.1%) has a positive direct effect on the SCBS. The value of the T statistic is also 16.232, which is greater than 1.96, and it shows that the observed correlation between two variables is significant [51]. Regarding the second relationship, it is safe to say that the path coefficient between the variables of this relationship is 0.707 [52]. That is, the variable of social and cultural restrictions (CSC) (70%)

has a positive and direct effect on the SCBS variable. The value of the T statistic was also obtained as 10.889, which is greater than 1.96 and shows that the observed correlation between the two variables is significant. Regarding relation three, we may infer that the path coefficient between the variables in this relationship is 0.773. That is, the economic and investment restrictions (CEI) variable has a positive and direct effect on the SCBS variable by 77.3%. The value of the T statistic is also 17.145, which is greater than 1.96 and shows that the observed correlation between two variables is significant. From relation 4, the following may be deduced: the path coefficient between the variables of this relationship is 0.895. This is because the legal restrictions variable (CL) has a positive direct effect on the SCBS variable by 89.5%. The value of the T statistic is also 65.598, which is greater than 1.96 and shows that the observed correlation between two variables is significant. Equation five shows that the path coefficient between the variables of this equation is 0.647. That is, the political constraints variable (CP) has a positive direct effect on the SCBS variable by 64.7%. The value of the T statistic is also 7.520, which is greater than 1.96 and shows that the observed correlation between two variables is significant.

3.8. Friedman Test

Finally, from the sixth relationship, Table 13 summarizes the Friedman test results. It can be concluded that the path coefficient between the variables in this relationship is 0.774. That is, the CMM management and marketing constraints variable has a positive direct effect on the SCBS variable by 77.4 percent. The value of the t statistic is also 16.308, which is greater than 1.96 and shows that the observed correlation between two variables is significant.

Table 13. The results of Friedman's test.

Dimension	Average Rank	Sig.	Degrees of Freedom	Rank
Restriction related to knowledge and Technology (CKT)	3.36	0.000	5	4
Social cultural Constraints (CSC)	3.66			3
Economic and investment restrictions	2.65			6
Legal Limit (CL)	4.24			1
Political restrictions (CP)	4.06			2
Restriction of management and marketing (CMM)	3.03			5

According to the results of the above table, the legal restrictions variable "CL" is ranked first with a rank of 4.24, and the indicators of political restrictions "CP" and socio-cultural restrictions "CSC" are also ranked second and third, respectively. Finally, the "CEI" index of economic and investment restrictions had the lowest rank and was the least prioritized.

4. Discussion

In this study, we aimed to identify and assess the obstacles to sustainable construction growth in Iran. Our findings shed light on the significance of these obstacles and their implications for achieving sustainable cities and infrastructure. The results of our study revealed that legal restrictions (CL) emerged as the most significant obstacle to sustainable construction in Iran, with a ranking of 4.24. This highlights the substantial impact of legal frameworks and regulations on the construction sector's ability to embrace sustainable practices. The high rank of legal restrictions suggests that addressing regulatory hurdles should be a top priority for policymakers and industry stakeholders. These findings emphasize the need for reforms and initiatives aimed at streamlining and improving the legal framework governing construction activities in Iran. Following closely behind were political restrictions (CP) and socio-cultural constraints (CSC), which ranked second and third, respectively. Political restrictions encompass factors such as government policies, bureaucratic processes, and political stability. These results underscore the interconnectedness of political stability and the construction industry's ability to pursue sustainable growth. Socio-cultural constraints encompass societal attitudes and cultural factors that may hinder the adoption of sustainable construction practices. Recognizing these constraints is vital for tailoring educational programs and awareness campaigns to promote sustainable construction among diverse societal groups. In contrast, economic and investment restrictions (CEI) were ranked the lowest and were the least prioritized obstacle in our study. While this may be surprising on the surface, it suggests that, to some extent, economic factors might be less restrictive in the context of sustainable construction. These finding challenges conventional wisdom, highlighting the need for a comprehensive analysis of the economic dimensions of sustainable construction in Iran. It suggests that investment in sustainable construction may be more feasible than previously thought.

Our findings align with some previous research in the field. Legal and political factors have consistently been identified as key challenges in the context of sustainable construction, corroborating the results of earlier studies. Al-Otaibi et al [53] represented lack of law enforcement, lack of regulation, and financial constraints as the four major barriers to effective and sustainable construction and demolition waste management in Developed and Developing Countries. The two most important factors identified are similar to the findings of the current study. Durdyev et al. [54] revealed that a clear and effective legislative process is crucial for the enforcement of the integration of SC materials and practices in Malaysia, another developing country similar to Iran. This study also revealed that economic incentives can ultimately lead to the effective implementation of SC initiatives.

In another study on Iran's construction management, Fathalizadeh et al. [55] found that economics and regulatory dependent barriers have a higher impact on the failure of a shift to sustainable practices in the country, which exactly aligns with present research outcomes. Tran et al. [56] focused on an investigation of the critical challenges general contractors are facing in executing green building (GB) projects in Vietnam. The result found that general contractors in Vietnam are facing four types of challenges, namely "Planning activities-related challenges", "Organizational activities-related challenges", "Onsite management and control activities-related challenges" and "Green supply chain-related challenges". Their findings suggest practical measures to enhance the success of GB projects in Vietnam, including completing the system of legal regulations and technical codes, standards, and guidelines, which point out to the importance of legal factors, as we have obtained.

However, the lower ranking of economic constraints suggests a departure from the prevailing discourse, encouraging further investigation into the nuanced economic dynamics of sustainable construction in Iran. The theoretical implications of this study are twofold. First, it contributes to our understanding of the obstacles to sustainable construction growth in Iran by quantifying their significance. Second, it challenges conventional assumptions about the economic barriers to sustainability in construction. These implications provide a foundation for future research to build upon.

On a practical level, our findings offer actionable insights for policymakers and industry stakeholders. Addressing legal restrictions, in particular, should be a priority. This could involve simplifying regulatory processes, revising outdated legislation, and providing clearer guidance on sustainable construction practices. Additionally, understanding the socio-cultural factors at play can inform targeted educational and outreach initiatives. Policymakers should also consider the potential economic opportunities in sustainable construction and explore strategies to incentivize investment in this area.

It is also important to acknowledge the limitations of this study. The sample size of 120 construction-related engineers and university professors, while representative, may not capture the full diversity of perspectives within the construction industry. Furthermore, the study's reliance on a Likert scale questionnaire and the use of SmartPLS software may introduce biases and limitations in the data analysis process. Future research could benefit from larger and more diverse samples, as well as a mixed-methods approach, to provide a more comprehensive understanding of these obstacles.

5. Conclusions

Construction management is a crucial subject within the field of sustainable cities and infrastructure, which is comprised of a number of essential concepts. Within the context of a developing nation like Iran, this research provides profound insights into the perspectives of construction practitioners regarding the impediments to sustainable construction. Through an exhaustive review of the existing literature, comprehensive analysis of influencing factors drawn from prior studies, and a carefully selected research approach, this study has examined the situation in the country. Demographic data were meticulously examined using descriptive statistics, followed by a robust inferential analysis presented through a series of Structural Equation Model (SEM) tests. These analytical processes revealed significant relationships between research variables. Foremost among these findings is the identification of legal restrictions (CL) as the most substantial barrier to sustainable construction in Iran, as indicated by the results of the Friedman test. Social and cultural constraints (CSC) and political constraints (CP) follow closely behind in terms of impact. These findings bear critical implications for policymakers. They provide a clear directive for the allocation of limited resources and policy reforms. However, it is essential to acknowledge the study's limitations. The utilization of self-report questionnaires may introduce biases stemming from respondents' motivations, education levels, and peer influence. Furthermore, it is important to recognize that the structural equation model employed in this study does not establish causation. In summary, this research stands as a beacon of guidance, enlightening the path toward sustainable construction in Iran. Its discoveries deliver a blueprint for policymakers and decision makers to navigate resource allocation and reform endeavors effectively. By addressing these identified obstacles, Iran can take significant steps toward the realization of sustainable cities and infrastructure, strengthening its role in the pursuit of a more sustainable future.

Author Contributions: All authors contributed to the development of this work; specifically, their contributions are as follows: Conceptualization, S.K. and F.D.; Methodology, S.K. and M.P.; Software, P.A.X.; Validation, P.A.X., R.M. and S.M.; Data Curation, F.D.; Writing—Original Draft Preparation, S.K., M.P. and F.D.; Writing—Review and Editing, R.M. and A.V.; Supervision and Resources, A.V. All authors have read and agreed to the published version of the manuscript.

Funding: The authors would like to thank Technical University of Liberec on Student Grant Competition SGS-2023–3401.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Participants were informed that their responses to the questionnaire would be treated entirely anonymously and confidentially.

Data Availability Statement: Not applicable.

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

References

1. Rooshdi, R.R.R.M.; Majid, M.Z.A.; Sahamir, S.R.; Ismail, N.A.A. Relative importance index of sustainable design and construction activities criteria for green highway. *Chem. Eng. Trans.* **2018**, *63*, 151–156. [CrossRef]
2. Cao, Y.; Dhahad, H.A.; Farouk, N.; Xia, W.-F.; Rad, H.N.; Ghasemi, A.; Kamranfar, S.; Sani, M.M.; Shayesteh, A.A. Multi-objective bat optimization for a biomass gasifier integrated energy system based on 4E analyses. *Appl. Therm. Eng.* **2021**, *196*, 117339. [CrossRef]
3. Rastbod, S.; Rahimi, F.; Dehghan, Y.; Kamranfar, S.; Benjeddou, O. An Optimized Machine Learning Approach for Forecasting Thermal Energy Demand of Buildings. *Sustainability* **2022**, *15*, 231.
4. Opoku, A. Biodiversity and the built environment: Implications for the Sustainable Development Goals (SDGs). *Resour. Conserv. Recycl.* **2019**, *141*, 1–7. [CrossRef]

5. Nundy, S.; Ghosh, A.; Mesloub, A.; Albaqawy, G.A.; Alnaim, M.M. Impact of COVID-19 pandemic on socio-economic, energy-environment and transport sector globally and sustainable development goal (SDG). *J. Clean. Prod.* **2021**, *312*, 127705. [CrossRef]
6. Li, X.-J.; Zheng, Y.-D.; Lai, J.-Y. Using LCA to research carbon footprint for precast concrete piles during the building construction stage: A China study. *J. Clean. Prod.* **2019**, *245*, 118754. [CrossRef]
7. Bajpai, R.; Choudhary, K.; Srivastava, A.; Sangwan, K.S.; Singh, M. Environmental impact assessment of fly ash and silica fume based geopolymer concrete. *J. Clean. Prod.* **2020**, *254*, 120147. [CrossRef]
8. Cheng, Z.; Wang, H.; Xiong, W.; Zhu, D.; Cheng, L. Public–private partnership as a driver of sustainable development: Toward a conceptual framework of sustainability-oriented PPP. *Environ. Dev. Sustain.* **2020**, *23*, 1043–1063. [CrossRef]
9. Milad, S.; Nariman, G.; Reza, E.; Parnaz, O.; Mohd, W.; Mohd, S. The Investigation of the Barriers in Developing Green Building in Malaysia. *Mod. Appl. Sci.* **2013**, *7*, 1–10. [CrossRef]
10. Darko, A.; Chan, A.P.C. Review of Barriers to Green Building Adoption. *Sustain. Dev.* **2016**, *25*, 167–179. [CrossRef]
11. Darko, A.; Chan, A.P.C.; Ameyaw, E.E.; He, B.-J.; Olanipekun, A.O. Examining issues influencing green building technologies adoption: The United States green building experts' perspectives. *Energy Build.* **2017**, *144*, 320–332. [CrossRef]
12. Gan, X.; Zuo, J.; Ye, K.; Skitmore, M.; Xiong, B. Why sustainable construction? Why not? An owner's perspective. *Habitat Int.* **2015**, *47*, 61–68. [CrossRef]
13. AlSanad, S. Awareness, Drivers, Actions, and Barriers of Sustainable Construction in Kuwait. *Procedia Eng.* **2015**, *118*, 969–983. [CrossRef]
14. Chan, A.P.C.; Darko, A.; Olanipekun, A.O.; Ameyaw, E.E. Critical barriers to green building technologies adoption in developing countries: The case of Ghana. *J. Clean. Prod.* **2017**, *172*, 1067–1079. [CrossRef]
15. Ametepey, O.; Aigbavboa, C.; Ansah, K. Barriers to Successful Implementation of Sustainable Construction in the Ghanaian Construction Industry. *Procedia Manuf.* **2015**, *3*, 1682–1689. [CrossRef]
16. Zulu, S.L.; Zulu, E.; Chabala, M.; Chunda, N. Drivers and barriers to sustainability practices in the Zambian Construction Industry. *Int. J. Constr. Manag.* **2022**, *23*, 2116–2125. [CrossRef]
17. Adabre, M.A.; Chan, A.P.; Edwards, D.J.; Mensah, S. Evaluation of symmetries and asymmetries on barriers to sustainable housing in developing countries. *J. Build. Eng.* **2022**, *50*, 104174. [CrossRef]
18. Djokoto, S.D.; Dadzie, J.; Ohemeng-Ababio, E. Barriers to Sustainable Construction in the Ghanaian Construction Industry: Consultants Perspectives. *J. Sustain. Dev.* **2013**, *7*, 134. [CrossRef]
19. Yin, B.C.L.; Laing, R.; Leon, M.; Mabon, L. An evaluation of sustainable construction perceptions and practices in Singapore. *Sustain. Cities Soc.* **2018**, *39*, 613–620. [CrossRef]
20. Santos, R.; Costa, A.A.; Silvestre, J.D.; Pyl, L. Informetric analysis and review of literature on the role of BIM in sustainable construction. *Autom. Constr.* **2019**, *103*, 221–234. [CrossRef]
21. Karji, A.; Namian, M.; Tafazzoli, M. Identifying the Key Barriers to Promote Sustainable Construction in the United States: A Principal Component Analysis. *Sustainability* **2020**, *12*, 5088. [CrossRef]
22. Hossain, M.U.; Ng, S.T.; Antwi-Afari, P.; Amor, M. Circular economy and the construction industry: Existing trends, challenges and prospective framework for sustainable construction. *Renew. Sustain. Energy Rev.* **2020**, *130*, S1364032120302392. Available online: https://econpapers.repec.org/RePEc:eee:rensus:v:130:y:2020:i:c:s1364032120302392 (accessed on 8 June 2023). [CrossRef]
23. Goh, C.S.; Chong, H.-Y.; Jack, L.; Faris, A.F.M. Revisiting triple bottom line within the context of sustainable construction: A systematic review. *J. Clean. Prod.* **2019**, *252*, 119884. [CrossRef]
24. Nasereddin, M.; Price, A. Developments in the Built Environment Addressing the capital cost barrier to sustainable construction. *Dev. Built Environ.* **2021**, *7*, 100049. [CrossRef]
25. Oke, A.E.; Kineber, A.F.; Albukhari, I.; Othman, I.; Kingsley, C. Assessment of Cloud Computing Success Factors for Sustainable Construction Industry: The Case of Nigeria. *Buildings* **2021**, *11*, 36. [CrossRef]
26. Sadeghi, M.; Mahmoudi, A.; Deng, X. Adopting Distributed Ledger Technology (DLT) For The Sustainable Construction Industry: Evaluating The Barriers Using Ordinal Priority Approach (OPA). *Environ. Sci. Pollut. Res.* **2022**, *29*, 10495–10520. [CrossRef]
27. Iqbal, M.; Ma, J.; Ahmad, N.; Hussain, K.; Waqas, M.; Liang, Y. Sustainable construction through energy management practices: An integrated hierarchal framework of drivers in the construction sector. *Environ. Sci. Pollut. Res.* **2022**, *29*, 90108–90127. [CrossRef]
28. Kamranfar, S.; Azimi, Y.; Gheibi, M.; Fathollahi-Fard, A.M.; Hajiaghaei-Keshteli, M. Analyzing Green Construction Development Barriers by a Hybrid Decision-Making Method Based on DEMATEL and the ANP. *Buildings* **2022**, *12*, 1641. [CrossRef]
29. Ayarkwa, J.; Opoku, D.-G.J.; Antwi-Afari, P.; Li, R.Y.M. Sustainable building processes' challenges and strategies: The relative important index approach. *Clean. Eng. Technol.* **2022**, *7*, 100455. [CrossRef]
30. Chigbu, U.E. Visually Hypothesising in Scientific Paper Writing: Confirming and Refuting Qualitative Research Hypotheses Using Diagrams. *Publications* **2019**, *7*, 22. [CrossRef]
31. Surucu, L.; Maslakci, A. Business & Management Studies. *Bus. Manag. Stud. Int. J.* **2020**, *8*, 2694–2726.
32. Naz, S.; Li, C.; Zaman, U.; Rafiq, M. Linking Proactive Personality and Entrepreneurial Intentions: A Serial Mediation Model Involving Broader and Specific Self-Efficacy. *J. Open Innov. Technol. Mark. Complex.* **2020**, *6*, 166. [CrossRef]
33. Hair, J.; Alamer, A. Partial Least Squares Structural Equation Modeling (PLS-SEM) in second language and education research: Guidelines using an applied example. *Res. Methods Appl. Linguist.* **2022**, *1*, 100027. [CrossRef]
34. Ali, S.; Yan, Q.; Razzaq, A.; Khan, I.; Irfan, M. Modeling factors of biogas technology adoption: A roadmap towards environmental sustainability and green revolution. *Environ. Sci. Pollut. Res.* **2022**, *30*, 11838–11860. [CrossRef] [PubMed]

35. Dauda, J.A.; Ajayi, S.O. Understanding the impediments to sustainable structural retrofit of existing buildings in the UK. *J. Build. Eng.* **2022**, *60*, 105168. [CrossRef]
36. Inoubli, C.E.; Gharbi, L. Entrepreneurial orientation and its crucial role in entrepreneurial intention and behaviour: Case of Tunisian Students. *Entrep. Educ.* **2022**, *5*, 97–121. [CrossRef]
37. Syahfitri, J.; Herlina, M. Online Learning Using Google Classroom for Biology Education Students During COVID-19 Outbreak. *Int. J. Biol. Educ. Towar. Sustain. Dev.* **2022**, *2*, 23–33. [CrossRef]
38. Yuan, Y.; Yang, K.; Cheng, L.; Bai, Y.; Wang, Y.; Hou, Y.; Ding, A. Effect of Normalization Methods on Accuracy of Estimating Low- and High-Molecular Weight PAHs Distribution in the Soils of a Coking Plant. *Int. J. Environ. Res. Public Health* **2022**, *19*, 15470. [CrossRef]
39. Kaizer, U.A.d.O.; Alexandre, N.M.C.; Rodrigues, R.C.M.; Cornélio, M.E.; Lima, M.H.d.M.; São-João, T.M. Measurement properties and factor analysis of the Diabetic Foot Ulcer Scale-short form (DFS-SF). *Int. Wound J.* **2020**, *17*, 670–682. [CrossRef]
40. Chen, H.; Shi, L.; Shi, Z.; Xia, Y.; Wang, D. Factors influencing physician's behavioral intention to use Traditional Chinese Medicine to treat coronavirus disease 2019 based on the theory of planned behavior. *J. Tradit. Chin. Med.* **2022**, *42*, 633–6400. [CrossRef]
41. Hanafiah, M.H. Formative Vs. Reflective Measurement Model: Guidelines for Structural Equation Modeling Research. *Int. J. Anal. Appl.* **2020**, *18*, 876–889. [CrossRef]
42. Rönkkö, M.; Cho, E. An Updated Guideline for Assessing Discriminant Validity. *Organ. Res. Methods* **2020**, *25*, 6–14. [CrossRef]
43. Kineber, A.F.; Siddharth, S.; Chileshe, N.; Alsolami, B.; Hamed, M.M. Addressing of Value Management Implementation Barriers within the Indian Construction Industry: A PLS-SEM Approach. *Sustainability* **2022**, *14*, 16602. [CrossRef]
44. Rostami, M.R.; Mirshahi, H. The Relationship Marketing Performance Evaluating in Financial Services Sector of Project Management. *Shock. Vib.* **2022**, *2022*, 9271823. [CrossRef]
45. Zamhariri, A.A.; Heirany, F.; Moeinaddin, M. Investigation of the strategic entrepreneurship components' effect on the knowledge-based companies' performance by applying new dimensions of balanced score card. *Int. J. Nonlinear Anal. Appl.* **2022**, *6822*, 1–24.
46. Ebrahimi, E.; Asadi, H.; Rahmani, M.; Bayat, H. Fingerprinting of Phosphorus in river sediments using the structural equation modeling. *Environ. Monit. Assess.* **2023**. *in review*. [CrossRef]
47. Tajpour, M.; Hosseini, E.; Mohammadi, M.; Bahman-Zangi, B. The Effect of Knowledge Management on the Sustainability of Technology-Driven Businesses in Emerging Markets: The Mediating Role of Social Media. *Sustainability* **2022**, *14*, 8602. [CrossRef]
48. Rogers, S.J.; Estes, A.; Lord, C.; Munson, J.; Rocha, M.; Winter, J.; Greenson, J.; Colombi, C.; Dawson, G.; Vismara, L.A.; et al. A Multisite Randomized Controlled Two-Phase Trial of the Early Start Denver Model Compared to Treatment as Usual. *J. Am. Acad. Child Adolesc. Psychiatry* **2019**, *58*, 853–865. [CrossRef]
49. Kouriati, A.; Moulogianni, C.; Kountios, G.; Bournaris, T.; Dimitriadou, E.; Papadavid, G. Evaluation of Critical Success Factors for Enterprise Resource Planning Implementation Using Quantitative Methods in Agricultural Processing Companies. *Sustainability* **2022**, *14*, 6606. [CrossRef]
50. Adam, M.H.M. Nexus among foreign direct investment, financial development, and sustainable economic growth: Empirical aspects from Sudan. *Math. Biosci. Eng.* **2022**, *6*, 640–657. [CrossRef]
51. Han, E.; Fritzer-Szekeres, M.; Szekeres, T.; Gehrig, T.; Gyöngyösi, M.; Bergler-Klein, J. Comparison of High-Sensitivity C-Reactive Protein vs C-reactive Protein for Cardiovascular Risk Prediction in Chronic Cardiac Disease. *J. Appl. Lab. Med.* **2022**, *7*, 1259–1271. [CrossRef] [PubMed]
52. Bali, P.N. The effect of customer relationship management on customer. *Indones. J. Bus. Entrep.* **2021**, *7*, 139–149.
53. Al-Otaibi, A.; Bowan, P.A.; Daiem, M.M.A.; Said, N.; Ebohon, J.O.; Alabdullatief, A.; Al-Enazi, E.; Watts, G. Identifying the Barriers to Sustainable Management of Construction and Demolition Waste in Developed and Developing Countries. *Sustainability* **2022**, *14*, 7532. [CrossRef]
54. Durdyev, S.; Ismail, S.; Ihtiyar, A.; Abu Bakar, N.F.S.; Darko, A. A partial least squares structural equation modeling (PLS-SEM) of barriers to sustainable construction in Malaysia. *J. Clean. Prod.* **2018**, *204*, 564–572. [CrossRef]
55. Fathalizadeh, A.; Hosseini, M.R.; Vaezzadeh, S.S.; Edwards, D.J.; Martek, I.; Shooshtarian, S. Barriers to sustainable construction project management: The case of Iran. *Smart Sustain. Built Environ.* **2022**, *11*, 717–739. [CrossRef]
56. Tran, Q.; Huang, D. Using PLS-SEM to analyze challenges hindering success of green building projects in Vietnam. *J. Econ. Dev.* **2022**, *24*, 47–64. [CrossRef]