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Forecasting the Impact of the Environmental and Energy Factor to Improve Urban Sustainability by Using (SEM)

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Abstract

The environmental and energy factor is one of the important factors that most studies have focused on in the field of sustainability, especially in light of the increasing population growth rates and the accompanying increase in consumption and environmental pollution rates. This paper focuses on presenting several different theories and models of urban sustainability for the purpose of identifying the overall factors that constitute it. Structural Equations Modeling (SEM) allows knowledge of the relationships and the strength of influence between these factors. The paper focuses on studying the environmental and energy factors and their impact on other sustainability factors. As most researchers resort to descriptive methods and measures in discussing the subject. The paper aims to adopt models and quantitative measures to determine the factors and indicators of urban sustainability and to clarify the importance, variation, and interdependence between these factors and indicators, adopting the hypothesis that structural equation modeling provides highly reliable tools through which sustainability factors, their relationships, and the mutual influence between them can be measured using the analysis of moment structures (AMOS) program. The result shows that the environmental and energy factors are highly related to the urban design factor (6.0).

Keywords: Urban Sustainability; Theories and Models; Environment and Energy; SEM; AMOS.

1. Introduction

The increase in human density, growth rates, and associated activities causes excessive consumption of resources and pressure on the natural environment [1]. Therefore, the concept of urban sustainability emerged, and the need to evaluate its presence in cities emerged. The assessment of urban sustainability is a useful tool for monitoring changes in urban areas, and it is an important policy for decision-makers to determine priorities and future plans to reach the correct assessment, as well as knowing the ability of cities and the urban system to deal with exceptional difficulties while preserving its structure, functions, and identity and continuing their work. In current resource management [2, 3]. The assessment of urban sustainability includes a wide range of factors and indicators, as well as adopting integrated methodologies, which provide a structured approach based on a more integrated perspective. Therefore, the assessment of urban sustainability must become an early, essential, and active part of the urban planning and design process, as well as its impact on the classification and evaluation of alternatives [4]. The method used in this research is a quantitative approach, relying on structural equation modeling and using confirmatory factor analysis. Data on factors and indicators that mostly affect urban sustainability have been analyzed by relying on relevance and quality standards and using several analytical steps using the Amos program [5].

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1.1. Literature Review

Sutthichaimethee et al. (2019) discussed economic growth based on the sustainable environment to predict the next 16 years (2020-2035) by applying the structural equation model (SEM) to verify the validity of the model and standards and its proportion with the best standards of appropriate quality. The model reflects the prediction of the economic factor and its ability to balance with the environmental factor, clarifying the relationship between factors and their direct and indirect impact. They found that the industry still negatively affects the environment by emitting CO_2, which is one of the largest risks and environmental disasters. They determined 80 million tons for the year 2035 [6]. Ahmad et al. (2020) addressed the nature of the relationship between the environment and the innovation factor and its role in shaping the links between natural resources and innovations. They found that long-term prediction emphasized the existence of a stable relationship between the environment, natural resources, and technological innovations. The innovation limits environmental degradation and also contributes to achieving environmental sustainability using natural resources in smarter ways, without a negative impact on the environment and future generations, as it works to develop renewable energy and reduce dependence on fossil fuels [7].

Bibri (2021) discussed sustainable urban design as a new framework for redesigning and restructuring urban areas to make urban life more sustainable. He assumed that compact cities and eco-cities are the most suitable models for sustainable urban form as well as represent a central model of sustainable urbanization. Urban design continues to strive for the required level of sustainability by enabling the built environment to operate in ways that reduce material use, reduce energy consumption, mitigate pollution, reduce waste, and improve social justice, human well-being, and quality of life [8].

Xia et al. (2022) focused on the importance of prediction and its role in urban sustainability, as it provides strong technical support for the physical environment and the future environment through various prediction methods and approaches, including various quantitative and relative methods. They propose prediction methods with indicators and characteristics of sustainability to solve the problems of densities, climate protection, urban energy conservation, and the transportation system, all of which deteriorate by increasing the future population, leading to an imbalance in urban spaces as well as buildings, so he proposed exploring living spaces and urban spaces under the earth [9]. Sutthichaimethee & Jittawiriyanukoon (2022) pointed to the impact of economic and social factors on the environment under the environmental law of Thailand. They formed a sustainable policy by applying the best model of the structural equation with external variables, as this newly developed model is distinguished from any previous models as it is effectively applied to any sector in all fields. The model is characterized by long-term prediction with the ability to determine appropriate future scenarios when evaluating the performance of the model and estimating the average error of social factors. The impact of economic factors on the environment is clear, with a maximum of 67%, while the impact of social factors on the environment is detected at 55%, as these effects are seen as exceeding the capacity of the specific environment [10].

Previous studies dealt with the factors and indicators of urban sustainability and their important impact on the environment and energy, some of which focused on renewable energy and reducing fossil fuels to mitigate pollution, while some studies suggested the adoption of long prediction methods to be more technical and effective in shaping the future by applying structural equations to show the impact of the economic factor on the environment. Other studies relied on urban design strategies and policies to orient buildings towards sustainability by conserving energy and reducing consumption.

The results of previous studies were used to develop the current paper and find useful results for future studies. The above-mentioned studies confirmed the correlation and relationship between the economic factor and its impact on the environmental factor through modeling structural equations and predicting the validity of the results and their treatment for future applications. The difference in this study is the relation of environmental and energy factors with all urban sustainability factors, analyzed by confirmatory factor analysis and statement of direct and indirect effects. This paper aims to develop and improve sustainability factors and indicators by addressing them in an integrated manner, as these indicators are interrelated and do not give an accurate result except for their coherence to fill the research gap. Moreover, the results of this paper can be applied to all urban contexts that want to achieve sustainability.

2. Theoretical Approach

2.1. Theories of sustainable Cities

In order to move to sustainable or more sustainable cities that evolve with technological changes, many theories have emerged, the most important of which will be addressed in this paper, namely: the theory of compact cities, the theory of the just city, the theory of biophilic cities, the theory of resilient cities, the theory of multi-technology cities [11], and the theory of the upward spiral [12] to clarify the goals and principles of environmental, economic, and social development and to know the intellectual orientations of each theory. The aforementioned theories contribute to identifying the intellectual orientations involved under their umbrella and will be addressed in the next paragraphs in detail, through which the main factors and indicators of urban sustainability can be reached (Figure 1).

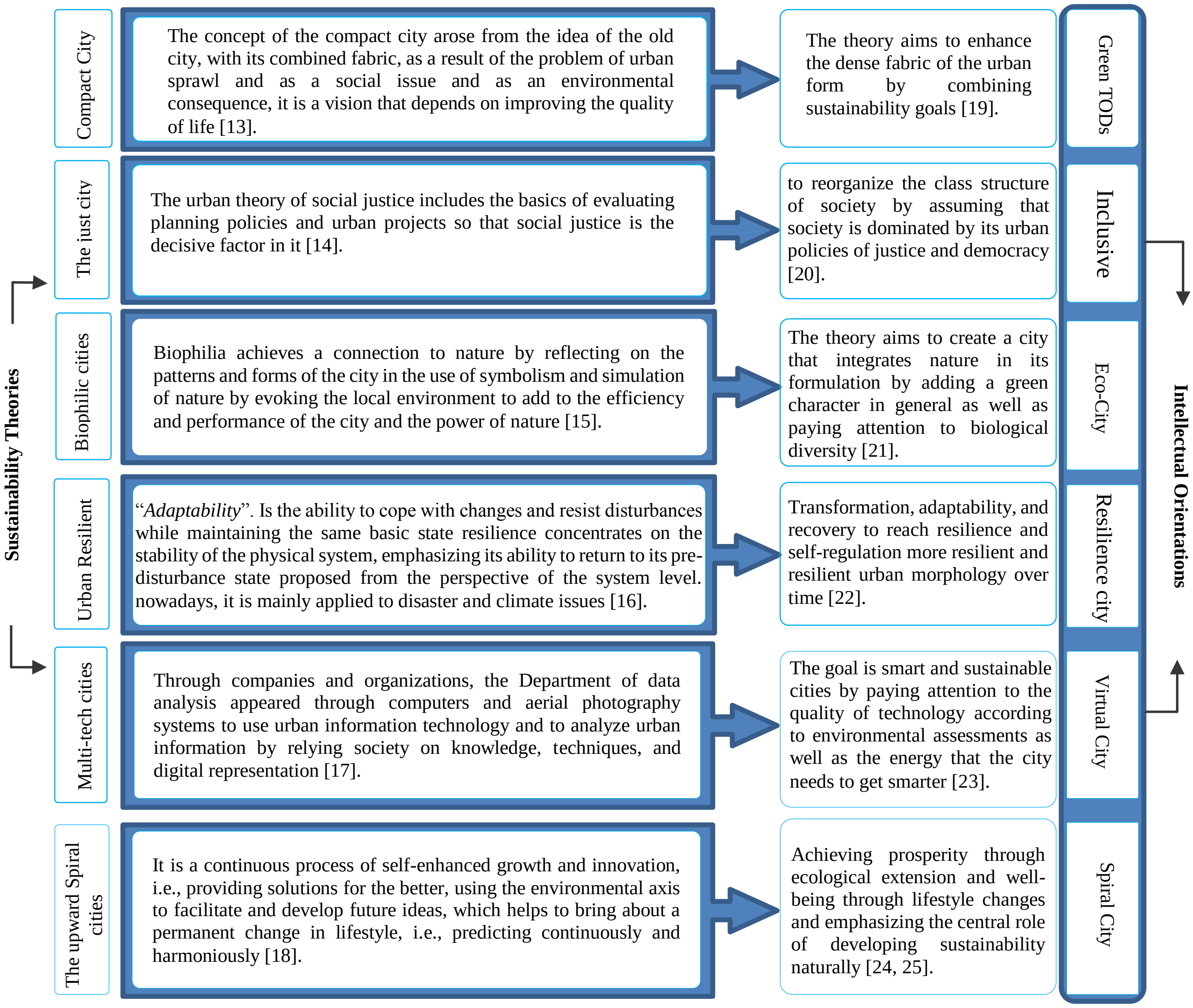

Figure 1. Theories of sustainable cities

- **Compact City:** It is a city characterized by a compact structure, as in the ancient cities. Created in response to urban sprawl. It has multiple dimensions, as it addresses social issues, enhances physical proximity, as well as environmental problems. Several compact city titles are included. Intellectual trends such as: High-density cities, TOD (transit-oriented development) and TND (new tradition neighborhoods).
- **Just City:** A pattern characterized by social mixing and fairness by equitable distribution without discrimination to lead to a new policy for urban renewal. Intellectual trends such as: Inclusive city and virtuous city.
- **Biophilic City:** It is a city that merges the place with nature by giving green character in general. It also works to favor the environmental dimension in all its joints Intellectual trends such as: Vibrant city, ecological city, vitality city and urban parks city.
- **Resilient City:** It is a city that has the ability to self-regulate morphologically to face changes, prevent disasters and recover from them after they occur. Intellectual trends such as: Urban resilience, the renewable city and carbon-neutral cities.
- **Multi-tech Cities:** A system that provides more efficient performance and advanced and innovative services. It has a futuristic range that solves many urban problems. Intellectual trends such as: Digital cities, informational cities, virtual cities, and electronic communities.
- **The upward Spiral Cities:** It is a city that has the ability to change its shape. It works to integrate the spiral shape of the system and the specific mechanisms of the city. It signifies continuous growth, self-reinforcing innovation, spiral expansion and development. It is her example the Spiral city.

2.2. Intellectual Orientations for Urban Sustainability

Each of the previous theories includes several intellectual orientations to models of sustainable cities. In this paper, the most common models that explain urban sustainability factors were chosen in a more comprehensive manner, as each factor allows for deriving a set of indicators that can be measured and analyzed practically (Table 1). The following is a detailed explanation of each orientation:

- **Green Transit Oriented Development (Green TOD) _ Compact City Theory:**

The TOD emerged to create more orderly, walkable communities formed around transit stops, as well as to focus on components that attract growth, create high density, and achieve mixed use in public spaces with the use of urban greening. TOD has proven to be a promising tool for expansion, and relying on a compact area development system would slow down urban sprawl [26].

- **Inclusive City _ The Justice City:**

This concept emerged as the beginning of a lifestyle linked to safe living in an urban area and has been organized by the "Inclusive Cities Program" "Building Inclusive Cities", which is an important opportunity to assess some of the current orientations in building safe and inclusive cities to access the more equitable opportunities that cities can provide, regardless of age, gender, race, and religion by making cities safer for all [27].

- **Eco-City Model_ Biophilia City Theory:**

The ecological city is an expression that refers to an urban unit that respects the principles of sustainability in all its aspects. It focuses on the environmental dimension to reach cohesion and integration that corresponds to the level of satisfaction of the population and the components of the urban spatial structure to maintain the environmental balance and the flow of life in the city. Examples were promoting green buildings and using the land in a diverse and balanced manner to highlight in its formulation public green spaces, forest areas, garden cities, the generalization of green transportation, and the promotion of renewable energy [28].

- **Resilience City _ Urban Resilient Theory:**

This trend was mainly reflected in the United Nations program in 2015 among the 17 goals to make cities sustainable. The urban resilience model is considered within Goal 11, that is, cities have resilience in the land and are able to face all crises, whether they are climatic, environmental, natural, or human accidents. This makes cities environmentally strong and adaptive, responding quickly to manage risks in order to survive. As well as creating more resilient urban communities to mitigate disasters and crises [22, 29].

- **Virtual City _ Multi-technical Cities Theory:**

Orienting the city using digital and visual modeling methods and smart environmental calculations for its community and infrastructure, through an electronic platform that simulates, synthesizes, and analyzes data at high speed. As well as having innovation to move sustainability from traditional topics to different and appropriate points in finding innovative solutions, and providing programs by communicating, and collaborating in a more efficient way that gives realistic, and predictive planning for the smart environments necessary for future high-performance [30, 31].

- **Spiral City_ The upward Spiral Cities Theory:**

The Spiral City Proposal was presented as an opportunity to keep pace with modernity in 2018, as a solution to the suburbs sprawl, to advance balance in the distribution of places and the constant proximity to the city center. It is characterized by flexibility, continuous and rapid development. It emerged as a dynamic field of sustainable solutions to transform the urban form into a more dynamic one. It uses the extension of urban public spaces in buildings and the expansion of spaces in cities, vertically connecting adjacent floors to enhance social interactions. As well as creating a series of sky gardens to reflect the natural living environment in buildings and create attractive architectural forms and vistas for cities [32].

Table 1. Urban sustainability factors and Indicators

Factor	Main indicator	Sub-indicator (secondary)
Land Uses	Diversity	Horizontal; vertical mix
	Spatial and functional continuity	Rate of change land use; developmental density
	Housing density	Density (net; total)
Accessibility	Traditional transmission patterns	Pedestrians, bicycles; private cars, buses
	Intelligent transport modes	Automatic transmission; electric transmission; electromagnetic machinery
	Occupational proximity	Distance traveled from the housing unit to various services and activities (transportation axes; neighborhood centers; recreational areas)
	Traffic Safety	Road Accidents; Bus Shortcuts, Emergency

Urban Design	Scales	Humane; friendly; commemorative
	Mass and space	The dominance of masses over space, porosity index
	Age of the building	Building features; historic areas
	Automation	Automatic control (colors; luminance; ventilation)
Innovation	Sensor Technology	Thermal; sensory and kinetic sensors; digital and visual maps
	Electronic Applications	E-Services; electronic education
	Coding technology	Audio and sensory devices; towers and signs for handicapped people
	Monitoring mechanisms	Surveillance Cameras; Thermal Radiation
	Internet Service	Free Wi-Fi; Optical Cable
Environment and energy	Energy Efficiency	Energy density; performance factor
	Waste Recycling	Waste Species; Waste Management
	Energy patterns	Conventional Energy; Renewable Energy
	Pollution patterns	Aerobic; soil; noise
	Biodiversity	Plant diversity; animal diversity
	Infrastructure	Water supply; electricity supply; sewage supply
	Landscaping	green areas; blue space
Socio-economic integration	Participatory	Social media; community participation in decision-making
	Employment	Availability of job opportunities public sector; private sector
	Investments	Residential, Health; Capital Investment
	Digital Embedding	E-Commerce, Visa Card; Digital Currency

2.3. Factors of Urban sustainability

Through the previous intellectual orientations of sustainable cities models, it was possible to conclude that there are six main factors for urban sustainability, namely:

- ***Land Uses:*** Land use planning has an important role in overcoming the problem of land availability in urban areas by forming dense patterns and spatial plans that emphasize the vertical growth of the city instead of the horizontal. As well as clarifying the level of occupancy density and approximating the various activities according to the principle of mixing (population workplaces), activating a sense of place (belonging), and renovating and rebuilding old and abandoned areas [33]. The land use factor refers to a set of human activities aimed at harnessing the services of terrestrial ecosystems that are the center of interactions between society and nature through indicators such as diversity in land-use patterns, proximity to jobs in the city, as well as land use density [34].

- ***Accessibility***: Green transport is the best solution to mitigate the negative effects of transportation, as sustainable transport is an urgent necessity imposed by life within cities. It is one of the most important factors for the advancement of cities economically, socially, and environmentally in the present and future [35]. Green transportation is very important in the city because of the pollution resulting from non-environmentally friendly means of transportation, which constitutes about half of the total air pollution. So, it encourages public transport using buses, the subway, and trams to be more ecologically and economically efficient than private cars, especially vehicles that rely on the renewable energy system [36].

- ***Urban Design***: This factor deals with regulating the relationship between mass and space through procedures that reduce energy consumption. These relationships reflect many environmental considerations. The idea of sustainability is linked to directing human functional activities within urban spaces and blocks. Therefore, spaces and blocks are required to be appropriately designed in terms of size, scale, color, materials, and lighting level. Urban design contributes to the making of places and the design quality of buildings and spaces to improve the physical and social aspects and make the design integrated and sustainable for living and adaptation [37, 38].

- ***Innovation***: Technology initiatives for inclusive cities lie in data platforms, systems based on mass data collection, and data-driven decision-making. It also allows applications to reach all segments of society to communicate more easily with the local government and to provide free Wi-Fi services in open, green spaces and public parks. As well as providing digital assistants through companies and integrated teams to transfer data to citizens (maps, brochures, environmental information, weather conditions). Urban sustainability calls for the development and promotion of innovation in the environmental sector in a collaborative manner between various institutions and universities through continuous monitoring and development mechanisms around the clock (numbers of visitors, incidents, administrative changes, quality of service information) [39, 40].

- ***Energy and Environment***: It is considered a very important factor, as it constitutes a large percentage of the city's area, because of the aesthetic, social, environmental, and economic functions it represents, such as open spaces of all kinds (for play, entertainment, relaxation, and recreation). This factor is closely related to environmental standards, energy efficiency, and reducing energy consumption to obtain a lighter environmental footprint that is beneficial to the environment, society, and a low-carbon future [41]. This factor refers to the challenges of climate change and the ability to find public policy tools to address problems flexibly and sustainably. As well as its link to reducing the causes of climate change through renewable energy systems based on energy consumption and reducing greenhouse gases, which requires readiness to face the challenges of replacing hazardous resources with friendly and clean ones [42].

- ***Social and Economic Integration***: This factor refers to the most efficient business of economic activities and benefits by concentrating activities close to each other so that the place is distinguished by economic prosperity and social stability. In addition, the density of the population in urban areas stimulates the emergence of activities, increases employment opportunities, reduces unemployment and poverty, and provides the population with a high quality of life by reducing family transportation expenses and increasing income to reach a self-sufficient city [43]. This factor focuses on the economic mechanism of smart cities, where various economic opportunities start at the local level to meet the challenges posed by the city, which enhances the opportunities for regional and global investments [44].

3. Research Methodology

Depending on the theoretical framework, the article relied on much previous literature that dealt with sustainability factors. Subsequently, these factors were measured through the AMOS program. The study discussed one of the important sustainability factors, which is the environmental and energy factor. Indicators of this factor were measured, and its relationship and impact on urban sustainability factors were analyzed. It should be noted that these secondary indicators of environment and energy can be applied in a general context in any country (see Figure 2).

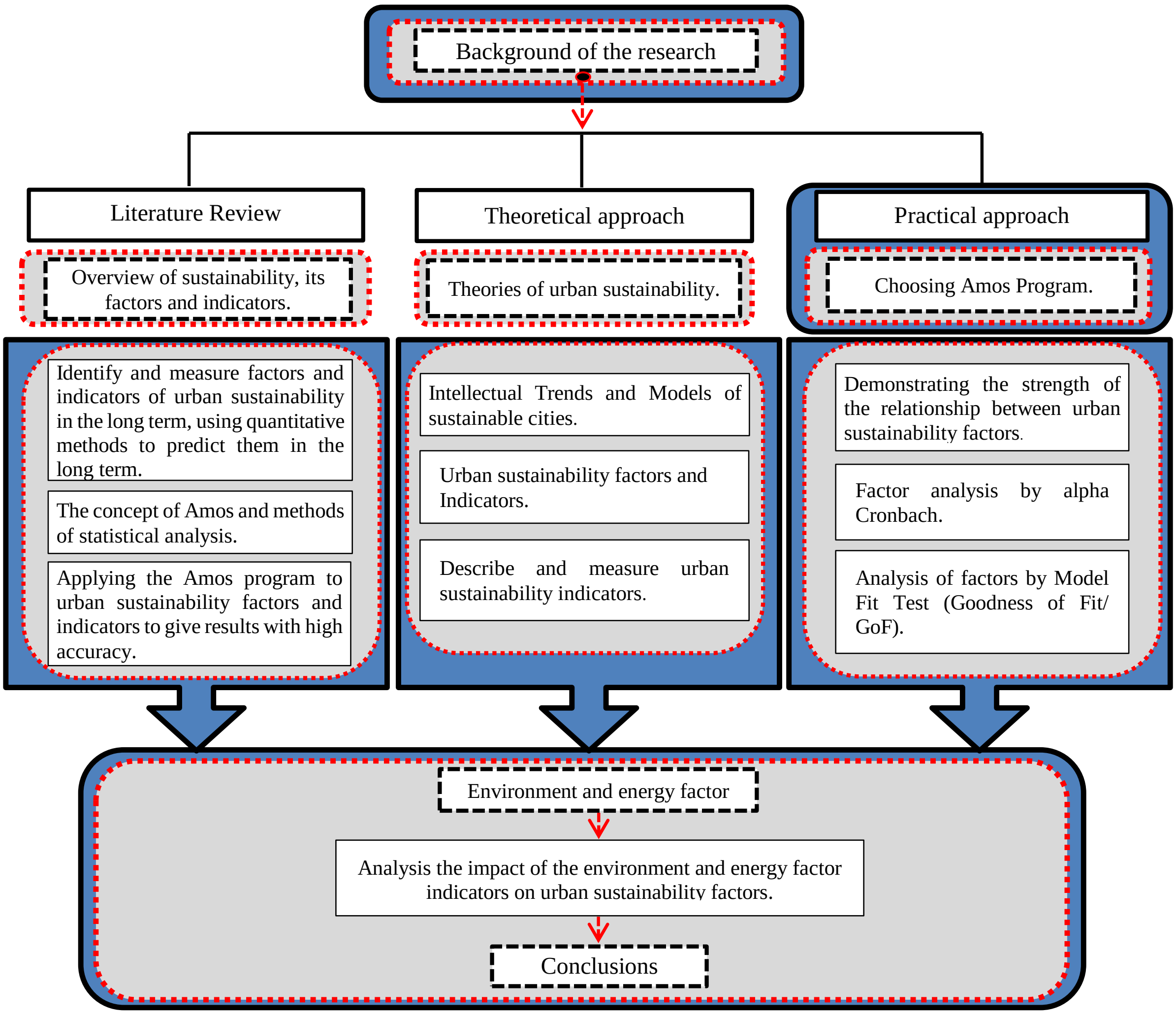

Figure 2. Research methodology

4. Methods

The AOMS program is one of the latest methods and programs used to test virtual models of phenomena in various sciences, as it is the best statistical program to use complex and overlapping data if the variables that the researcher is studying are multiple, and the Amos program allows the implementation of statistical analysis of all factors with the possibility of achieving correlation and interpretation of variance. It is also called the new generation based on an exploratory affirmative method [45].

4.1. Formulation of the Form

This research was conducted using a questionnaire with 200 samples. Were analyzed by Structural Equation Modeling (SEM) with the AMOS program. [46] The drafting process requires going through two basic stages of model formulation. The first stage, which is represented by the basic model [47], shows the relationship of the six factors with prediction. The second stage is the final structural model, which illustrates the relationship and impact of secondary indicators for the environment and energy factors on all urban sustainability factors. The default basic standard model of prediction consists of six factors: land use (F1), Accessibility (F2), urban design (F3), innovation (F4), environment and energy (F5), and social and economic integration (F6). These factors are non-measurable phenomena, so each factor includes key indicators, including sub-indicators to measure. Estimating the measurement model requires going through two stages of analysis. The first is to measure the stability of the factorial structure of each variable latent (factors), then comes the stage of calculating the validity of the factor structure of this variable.

4.2. Composite Reliability

The Cronbach's Alpha Coefficient: is calculated to measure the internal stability and the strength of the cohesion of the factors together in measuring the sample structure. Stability is obtained when the magnitude of the alpha Cronbach coefficient is greater than 0.70. On the other hand, this type of stability aims to measure measurement errors (random errors), where the stability coefficient increases as the number of questionnaire questions increases. Before starting the modeling process in the structural equation, it is necessary to conduct a stability analysis (Analysis for Reliability). To measure the strength of correlation and cohesion between the paragraphs of the prepared questionnaire, the alpha coefficient is one of the important indicators because it gives a lot of confidence in the validity of the response and estimating the degree of measurement. It is free of randomness and allows for determining the reliability of factors. It is one of the most common methods for assessing reliability, and the alpha coefficient ranges from 0_1, where the higher numbers closer to 1 indicate a more reliable scale, and the acceptable level is 0.7 [48].

Through the results of Cronbach's alpha analysis for all factors used in this paper, an internal consistency is observed. The results showed in Cronbach's alpha analysis that it is not less than 0.70, as the value of internal consistency ranged between 0.7-0.9, and this indicates a high internal consistency in the dimensions of the study and a high percentage of accuracy, as the highest value of the factors was equal to 0.846 for the social integration factor and economic factor, and the lowest value of 0.726 for the land use factor. The total value of the model was 0.828, and this is shown in Table 2.

Table 2. Analysis of (alpha Cronbach')

N	Factors	Cronbach alpha values per factor
1	Land uses	0.726
2	Accessibility	0.734
3	Urban Design	0.797
4	Innovation	0.803
5	Environment & Energy	0.776
6	Socio-economic integration	0.846
0.828 Total value of the model		

Specific Criteria for Estimating the Initial Structural Model: After ensuring the stability of the standards and matching indicators, the parameters for forming the model were determined, where each factor consists of 3–8 paragraphs, representing the main indicators for each factor. The average correlation between indicators and factors ranged from 0.5 to 0.8, the value of the correlation of the main factor with other factors ranged from 0.3 to 0.5, and the closer the value to 1, the better, as was the extent of missing data (2–20% for each indicator) [49]. When testing the initial structural model, it was found that it did not meet the standards of Goodness of Fit, and therefore several modifications were made to it to reach the acceptable model (see Figure 4 and Table 3).

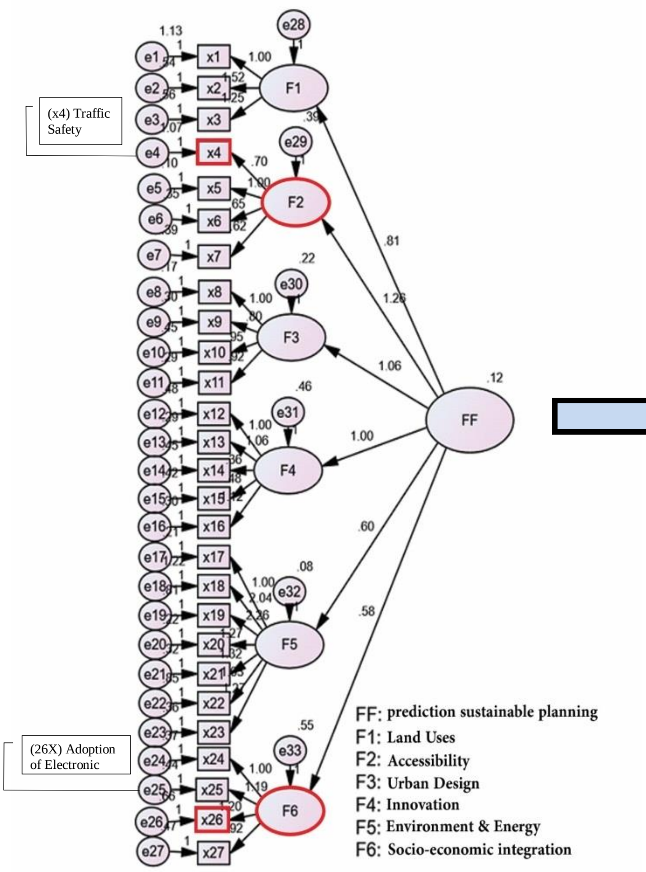

Figure 3. The basic structural model before modification

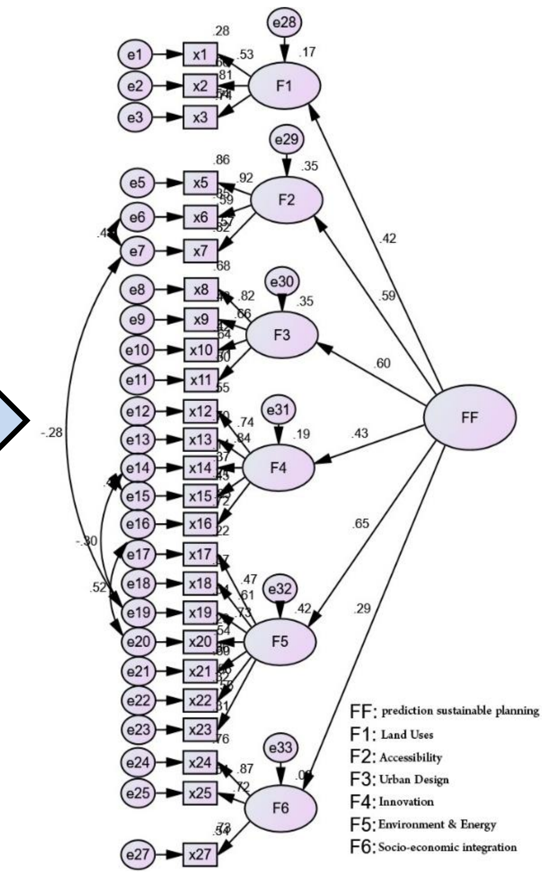

Figure 4. The basic structural model after modification

Table 3. Analysis of (Model Fit Test Goodness of Fit/GoF of factorial structure)

Indicator Name	The Goodness of Fit Results (Criterion)	Default model values (Before modification values)	Default model values (After modification values)
chi-square	Less than that is non-functional	690.431	385.124
Df/cmin ratio*	The value of this ratio is less than 5	2.164 so the value of the degree of freedom is 319	1.453 so the value of the degree of freedom is 265
Good fit index (GFI)	GFI ≥ 0.90	0.763	0.85
Adjusted good fit index (AGFI).	AGFI ≥ 0.90	0.687	0.801
Tucker - Lewis index (TLI)	TLI ≥ 0.90	0.734	0.905
Normed fit index (NFI)	NFI ≥ 0.90	0.634	0.911
Comparative fit indices (CFI)	CFI ≥ 0.95	0.758	0.908
RMSEA	≤ 0.05	0.089	0.056

* i.e., chi-square division by the degree of freedom.

The statistical model describes the fit of the values to the standard indicators under the relevant model. It is noted that both GFI index 0.85 and AGFI index 0.801 did not reach the ideal degree, but it is considered a good value as it approaches 0.9. This analysis of the model is due to several reasons, the most important of which is the size of the indicators and inputs. In addition to the repeated answers because the sample is from experts, or it may be contradictory. The model also contains many degrees of freedom, as it is considered one of the most restrictive models. In general, the closer the model is to ideal, the more it becomes unrealistic and cannot be applied [50, 51].

5. Results

5.1. The Impact of Factors

Through reviewing the Figure 5, the following can be found:

- The basic structural model of the prediction achieves a good match for urban planning factors, as the highest value of the environment and energy factors was recorded, which amounted to 0.65. This value confirms the world is moving towards predicting clean energy sources to reduce pollution and climatic fluctuations and encourage the increase of green and blue spaces, as they are the basis for sustainability. Preserving biodiversity and adopting recycling are essential services necessary for the development of society in all fields.

- The urban design factor has a value of 0.60, which is no less important than the previous factor. It is considered an important factor in designing the city and buildings according to human standards compatible with man and nature while preserving and making historical buildings. This factor can make the city a monument that reflects the identity and culture of the community. Focusing on distinctive architectural styles and mixing buildings with smart systems that reduce energy and make it a sustainable city for present and future generations.
- The accessibility factor has a value of 0.59. It has a high value and has a significant impact on future predictions. Transportation is one of the most common problems facing cities. The endeavor to develop solutions to access problems must be in sustainable and environmental ways. Therefore, it is necessary to rely on an advanced transportation system that employs technology and proximity to all uses to achieve urban sustainability.
- The innovation factor, which amounted to 0.43. The value indicates that the effect of this factor is relative because it is determined by several factors. This factor is another aspect of prediction and future exploration that determines the correct course of the world. The factor can stimulate the formation of a structure closer to the ideal through electronic technologies and applications among all segments of society, as well as the availability of free sites in tourist areas and public buildings.
- The land use factor amounted to 0.42. It is a good ratio based on horizontal and vertical diversity and moderate density. This is one of the main indicators of sustainable cities.
- The social and economic integration factor had a value of 0.29. It is an acceptable impact rate due to the fact that the sub-indicators of this factor had a negative impact with a number of 4 out of 7 indicators, which led to making the impact at an acceptable level. This gives a clear explanation of the community's use of technology and electronic social communication and the community's demand for goods and services through websites. This has greatly affected social and economic integration.

After verifying the basic standard model and its conformity with the scales. In this paragraph, the total structural model will be tested to predict the way of knowing the relationships and effects of the independent and dependent variables. All factors will be collected together to ensure that one-dimensional measurements are used on the model factors using the modeling of structural equations by the AMOS program. See Figure 3. Through modeling the direct effects of statistical significance and indirect effects on the factors of the assumed model of prediction. Then, test the impact of secondary indicators for each factor on the rest of the factors separately to identify indicators of statistical and non-statistical significance and then exclude them.

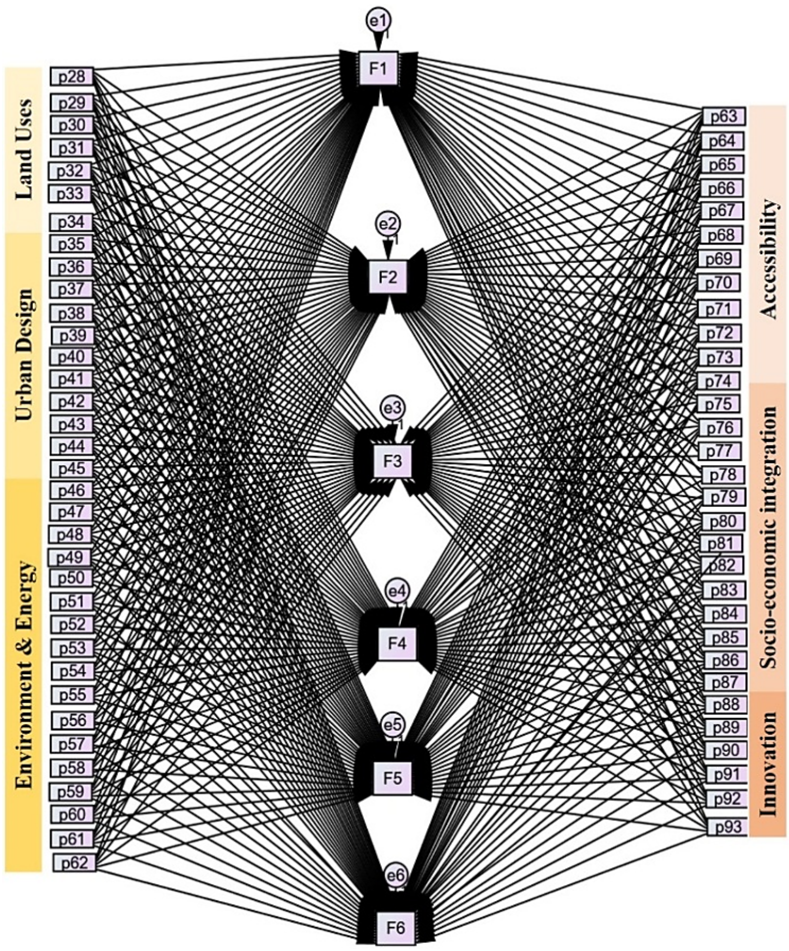

Figure 5. The basic structural model before modification

5.2. The Impact of Secondary Indicators

In this part, the structural test will be conducted for the secondary indicators of the environment and the energy factor. By analyzing the relationships of these indicators, the following is found (see Figure 6):

The increase in green spaces and open spaces in the city**:** it is statistical significance and has an impact on the land use factor. It is an important component of urban lands, especially with high or moderate densities, because of its aesthetic, health, and environmental values. Green and open spaces should be increased within the land. It also affects the urban design factor through its effect on increasing the space-to-mass ratio.

Blue areas: It is statistically significant; it has an effect on the land use factor. It is an approach to the system of open spaces to contribute to the production of cities free from environmental problems, and its presence is important, especially for cities with high and medium density.

Dependence of local energy production: It has statistical significance; it has an effect on the access factor. Reliance on local energy through renewable energy reduces the use of fossil fuels, which are widely used in the transportation system, and replaces them with environmentally friendly local energy sources.

Adopting recycling as a basic service*:* It is statistically significant, and it has a strong impact on the environment and energy. Waste is one of the most important environmental problems that the world suffers from, as the amount of waste is increasing. Recycling reduces the burning of waste to a minimum, reduces waste generation, and converts waste into useful and environmentally friendly products. This helps mitigate harmful environmental effects.

Reducing air pollution: It is statistically significant; it has a direct impact on the factor of social and economic integration through increasing social contact in communities and green areas because air pollution contributes to reducing social contact.

Preferring an increase in animal diversity to preserve biodiversity: it is statistically significant and has a direct and negative effect on the access factor. The potential effects of traditional transportation and traffic jams, such as those resulting from high levels of lead and other atmospheric pollutants, cause the death and extinction of many animal species.

Weighting the increase in plant diversity to preserve biodiversity: it is statistically significant, with a direct impact on the environmental and energy factors. It is the strongest natural defense against climate change, and it is the main driver of the web of life, so we always strive to increase squares and green spaces in the city.

Relying entirely on energy from a renewable energy source: It is statistically significant; it has a direct and strong impact on the factors of accessibility and innovation. Transportation is one of the most difficult sectors due to the pollution resulting from it. Therefore, in the next twenty years, it will be necessary to rationalize the uses of renewable energy in the transportation sector to achieve sustainable development and to make it a clean alternative energy through innovations that reduce the use of fossil fuels.

As for the rest of the indicators, they were not statistically significant, as shown in Figure 6.

6. Discussion

This research included identifying and analyzing 6 factors, 27 main indicators, and 64 secondary indicators. Which were analyzed by adopting a statistical model, SEM. Through this model, it was found that there are other factors and indicators that still need to be identified and studied in order for the model to be more reliable. The results showed that the model used needed many modifications before it reached usable form.

The environment and energy factors are associated with 16 secondary indicators, but only 8 of these indicators have a direct impact on sustainability factors. Indirect factors were neglected because of their weak effect on the model.

Through studying the relationship of environmental and energy factors with other urban sustainability factors. It was found to achieve close associations with factors of urban design and accessibility, while it achieved an association with medium values with factors of innovation and land use. The correlation value of this factor was weak with the factor of socio-economic integration. This indicates that controlling the urban aspects reduces energy consumption and improves the environment by controlling the indicators of these factors, while the economic aspects come in second place. Finally, the social aspects. As it has a weak statistical significance in correlation with the factor under study.

It was found that the environmental and energy factor indicators affect each other. Reducing the use of fossil fuels, using clean energies and recycling techniques, as well as increasing green and blue spaces. That is positively reflected in the preservation of animal and plant diversity. Biodiversity is an important measure of the sustainability of cities today (see Figure 7).

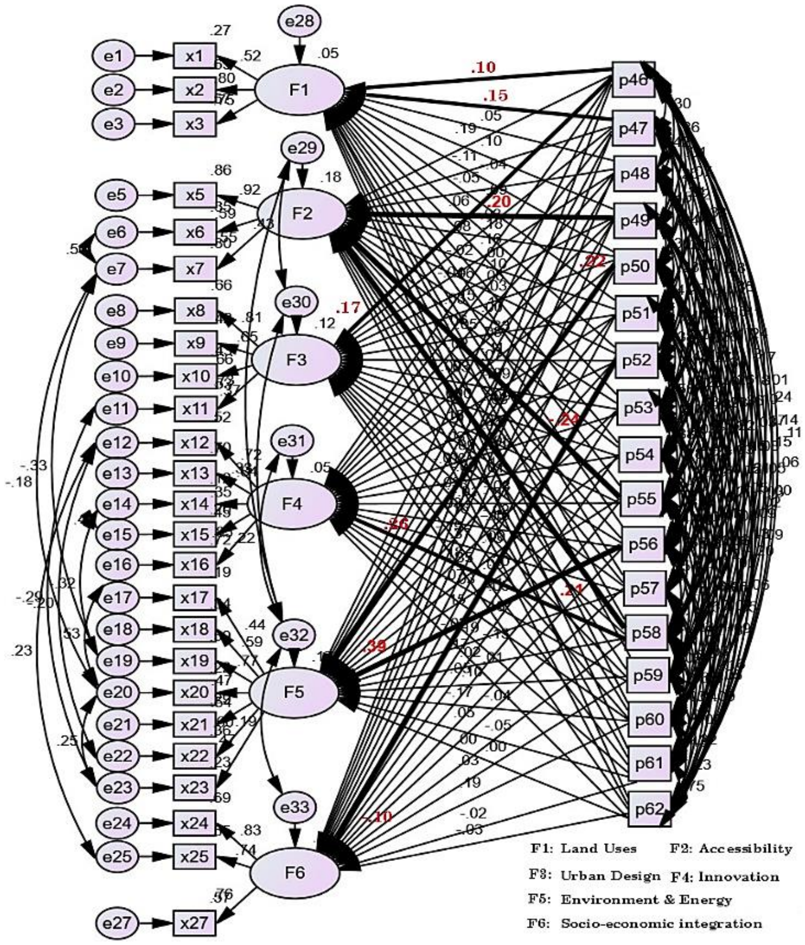

Figure 6. The basic structural model before modification

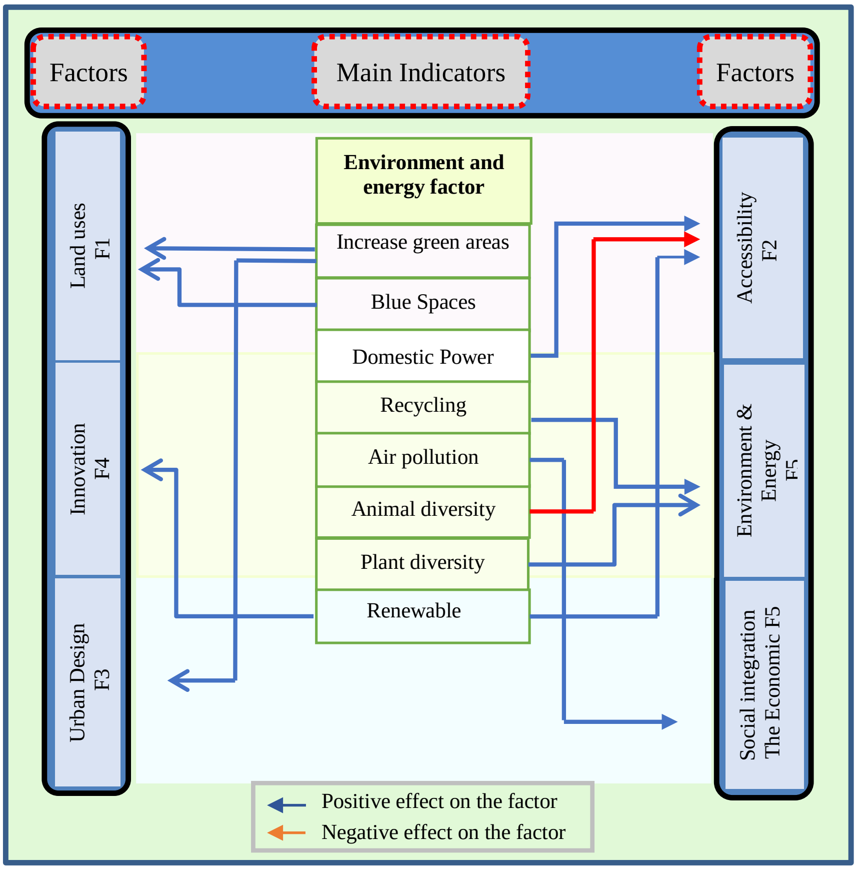

Figure 7. The impact of secondary indicators of the environment and energy factor on urban sustainability factors

7. Conclusion

The research developed a model based on previous literature. It is a model that presents the relationship of variables inherent in six main elements: land use, accessibility, urban design, innovation factor, environment, energy, and socio-economic integration. It also enables the use of the observed variables as secondary variables in each factor.

Studying and analyzing the prediction of the environment and energy factors is very important. It works to meet future challenges and rapid changes, as well as meet needs through the development of energy technologies. Forecasting and simulation models enhance economic prosperity and environmental security in the future through the development of alternative energy plans in the long term. By following the best scenario, it is possible to activate the reduction of pollution, environmental emissions, and the depletion of natural resources.

The environmental and energy factors affect and are affected by all factors of urban sustainability. The accessibility factor is most closely related to it. There are three indicators within the environment and an energy factor that affect accessibility. This indicates the significant role and influence of the transportation system on the environment and energy factor, as environmental planning requires taking into account energy consumption and activating sustainable methods of producing it. Through adopting environmentally friendly modes of transportation as well as smart.

The SEM model of structural modeling provides the possibility to derive the observed variables that reflect the latent variables. It also provides the possibility of estimating it using the methods of factor analysis and model quality assessment, as well as the analysis of variance. It can be presented in the form of an equation or a path diagram for better understanding and verification of the model.

8. Declarations

8.1. Author Contributions

Conceptualization, A.S.A. and Y.F.A.; methodology, A.S.A.; software, Y.F.A.; validation, A.S.A. and Y.F.A.; formal analysis, A.S.A.; investigation, Y.F.A.; resources, A.S.A.; data curation, Y.F.A.; writing—original draft preparation, A.S.A.; writing—review and editing, A.S.A.; visualization, A.S.A.; supervision, A.S.A.; project administration, Y.F.A.; funding acquisition, A.S.A. All authors have read and agreed to the published version of the manuscript.

8.2. Data Availability Statement

Data sharing is not applicable to this article.

8.3. Funding

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8.5. Conflicts of Interest

The authors declare no conflict of interest.

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