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Analysis of Urban Environment Sustainability in Kurdish Cities of Iran Using the Future Study Approach (Case Study: Saqqez City)

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Abstract

The present study attempts to analysis the spatial transformations in the urban environment scale by utilizing the natural step foresight approach in the context of urban environment indicators. To obtain this goal, the methods applied herein included descriptive-analytical studies, document and questionnaire in the frame of Delphi model and software analyzes. Initial discussions were held with 50 academic elites and executives in Saqqez city as the statistical population, followed by the identification of 78 variables in the frame of 16 general classifications. The results showed that the obtained fill rate was equal to 95.79% with two data iterations, which represented the highest level of variables influencing each other. According to the findings, the integrated urban environmental management index (ME4) with 188 scores had uppermost direct impact on other variables. Moreover, the index of development and promotion of urban recycling regulations with 5,585,944 calculated raw values presented the most indirect impact on other variables. Finally, the use of SMIC resulted in favorable, intermediate and catastrophic scenarios by considering the identified key driving forces.

Keywords: spatial analysis, urban environment, future studies, scenario planning

1. Introduction

There is an unequal urban growth taking place all over the world, but the rate of urbanization is very fast in developing countries, especially in Asia. In 1800 A.D., only 3% of the world's population lived in urban centers, but this figure reached 14% in 1900 and about 65% (3 billion) of people were urban inhabitants in 2016 [1]. Sustainability may seem like one more buzzword, and cities and towns like the last places to change, but the natural step for communities provides inspiring examples of communities that have made dramatic changes towards sustainability, and explains how others can emulate their success [2]. In the meantime, the natural step believes the root causes for unsustainability should be taken into

account when designing for sustainable solutions and satisfaction of fundamental needs. These root causes are derived from a scientific understanding of our social-ecological systems—the interactions between humans in society and between humans, their organizations and the ecosystem [3]. Its biggest advantage is the concept of “simplification without reduction” to prevent getting lost in the details with the complex topic of sustainability. For almost 30 years, the approach has been implemented, proven and refined in education, research, businesses, municipalities, regional and national governments, intergovernmental organizations [4]. Since, the main theme of any geographical analysis is to emphasis on the space and its environmental concepts, any change in the relationship between humans and the urban environment can be considered as the final product of the human desire to change the settlement areas in order to overcome the environmental and spatial nature of the city. In this context, spatial changes in the urban environment can be considered as socioeconomic, environmental, political and spatial policy functions, which had different implications of the urban space according to its various conditions at different periods of time, making the concepts of space and urban environment with the fundamental transformation [5, 6]. On other hand, various aspects of human life have been affected due to the rapid development of urbanization in recent decades. So, urban sustainability is in fact related to the world sustainability. Accordingly, the role of cities and their impacts on the sustainability criteria have attracted the attention of many scientists [7]. Considering the WHO annual report, rapid, unplanned and unsustainable patterns of urban development are making developing cities focal points for many emerging urban environmental challenges. As urban populations grow, the quality of the urban environment will play an increasingly important role in public health with respect to issues ranging from solid waste disposal, provision of safe water and sanitation and injury prevention, to the interface between urban poverty, environment and health. Thus, unsustainable patterns of urban planning in the third world cities and urban land use planning are a driver, or the root cause, of a number of significant and interrelated urban environmental and health hazards faced by urban dwellers in developing countries. These health and environment linkages cut across a range of policy sectors and thus are often overlooked in policy making. They are a focus of this priority risks section on the urban environment [8–10].

In the view of the World Bank, it should be stated that urban environmental problems are often blamed on poverty. Most often, urban affluence is viewed as an environmental burden. Meanwhile, middle-income cities are often cited as extreme examples of urban environmental distress. A stylized account of an urban environmental transition can help explain these superficially contradictory claims in terms of the different environmental burdens typically associated with cities at different levels of affluence. However, urban poverty is not strongly associated with environmental degradation in the sense of overuse of finite natural resource bases or the generation of ecologically damaging or disrupting wastes. It is the consumption patterns of non-poor groups (especially high-income groups) and the largely urban-based production and distribution systems that serve those that are responsible for most such degradation caused by urban populations [11]. In this respect, urban environmental subjects can be joined to the sustainable urban development issues. Therefore, a successful city must balance social, economic and environmental needs: it has to respond to the pressure from all sides. A successful city should offer investors’ security, infrastructure (including water, energy, population, management, environmental rules, etc.) and efficiency. It should also put the needs of its citizens at the forefront of all its planning activities. A successful city recognizes its natural assets, its citizens and its environment is built on these to ensure the best possible returns [12]. In the city context, this means that sustainable

urban development is not a choice but a necessity if cities are to meet the needs of their citizens. Urban centers must be socially equitable, economically successful and environmentally sustainable if cities are indeed to be the home of humanity's future [13].

Considering the above explanations, the strategic environmental assessment (SEA) is a process to ensure the identification and assessment of environmental effects likely leading to policies, plans and programs. SEAs also ensure that environmental effects are mitigated, communicated to decision-makers, monitored and opportunities are provided for public involvement. A SEA examines the need for social progress, effective environmental protection, prudent use of natural resources and economic growth [14]. During the 1980s, ideas about urban environment-development relationships were changing dramatically and by the time of the Earth Summit in Rio (1992), it was widely accepted that environment and development must go forward together and in balance—in other words, towards a sustainable development. The Second United Nations World Conference on Human Settlements (Habitat II—the “City Summit”) in Istanbul (1996) further considered this point in its global agenda for cooperation by acknowledging the direct and vital contribution that productive and sustainable cities can make to social and economic advancement. This understanding has been widely accepted among those concerned with the management of cities around the world, and has become the basis for new concepts and approaches to urban environment-development relationships [15]. In brief, the argument has three points:

- Sustainable cities are fundamental to social and economic development;
- Environmental degradation obstructs the development contribution of cities; and
- Environmental deterioration is not inevitable [16, 17].

Then, we can make a conclusion that urban environmental issues are multiple subjects and they are in the direct relationships to sustainable urban development and future strategies approaches. In this context, urban environment from Carson's view is an ecosystem or an environment that consists of components and elements such as resources, processes and their impacts on local plants and animal communities, human life, soil, water and air (as the natural environment), resources and processes as well as associated impacts on buildings, housing, roads and infrastructures (as the built environment), resources and processes. Besides these are also the environmental effects of human activities such as education, health and arts (as the social and economic environment) as a result of human activities and conversion of resources and raw materials to the product and requirement services in the urban scale. Therefore, urban environment was affected by these processes which can be considered as positive or negative impacts on human life in urban centers [18–20]. Accordingly, the natural step (TNS) is a naturalist approach founded in Sweden by scientist Karl-Henrik Robert (1989). In the context of urban environmental issues, this approach is formed from a series of strategic plans together with approaches of future studies. Therefore, future studies in connection with urban environment dimensions are some collective efforts that will be applied by analysis of the change or stability of agents focusing on the visualization of potential future and planning to achieve environmental objectives in urban spaces [21, 22]. The problems that cities are facing with today may be similar to those of the future cities but with greater compounding effects. Consequently, policy actions for developing sustainable city futures ought to be applied, tested and transferred to

help solve problems for other cities [23, 24]. It can be stated that scarce researches have been conducted about the urban environmental crisis in terms of future and strategic studies. So, this study tries to analysis the opportunities and challenges of the urban environment using TNS approach (scenario and strategic planning) in the context of future study. On this basis, it is essential to pay attention to and try to solve the urban environment challenges.

2. Study area

Saqqez city covers approximately 1474.8 ha located between 46°13' and 46°16' eastern longitude and 36°11' and 36°15' northern latitude within the north-west of Kurdistan province in the northwest of Iran. According to the 2006 census, the city's population was 135,037 people, whereas its current population is about 145,000 individuals. The building area was reported to be 618.26 ha. The average elevation of the city is about 1496 m above mean sea level. Saqqez city is characterized as a mountainous area located within Zagros Mountain range from southeast to north-west.

This area comprises about 15.5% of Kurdistan province. The difference of height between the highest elevation and the lowest point (Chehel-Cheshme Mountain 3173 m and Symone-Rood basin 1150 m above mean sea level) is about 2023 m. Saqqez River emanates from western mountains (Khan valley) and continues its path across the city towards northeast. **Figure 1** shows the location of study area in Kurdistan province, Iran [25] with a 987 km² common border with Iraq. The western border of Iran was specified by the border commission according to the Goldsmith Plan in September 1871 [26]. This borderline has separated parts of Kurdistan from Iran [27] and today a majority of the Kurdish population (about 25 million people) lives within Turkey (a group of Kurdish people also lives in Iran, Iraq and Syria [28]). Kurdistan province in Iran has been reported to have the lowest level of development [29–31]. Saqqez as the second largest city of Kurdistan province in Iran has faced several challenges and opportunities in the field of the urban environment. In recent years, due to the maladministration, a lot of these environmental capacities has been destroyed, and it is expected that in the near future, due

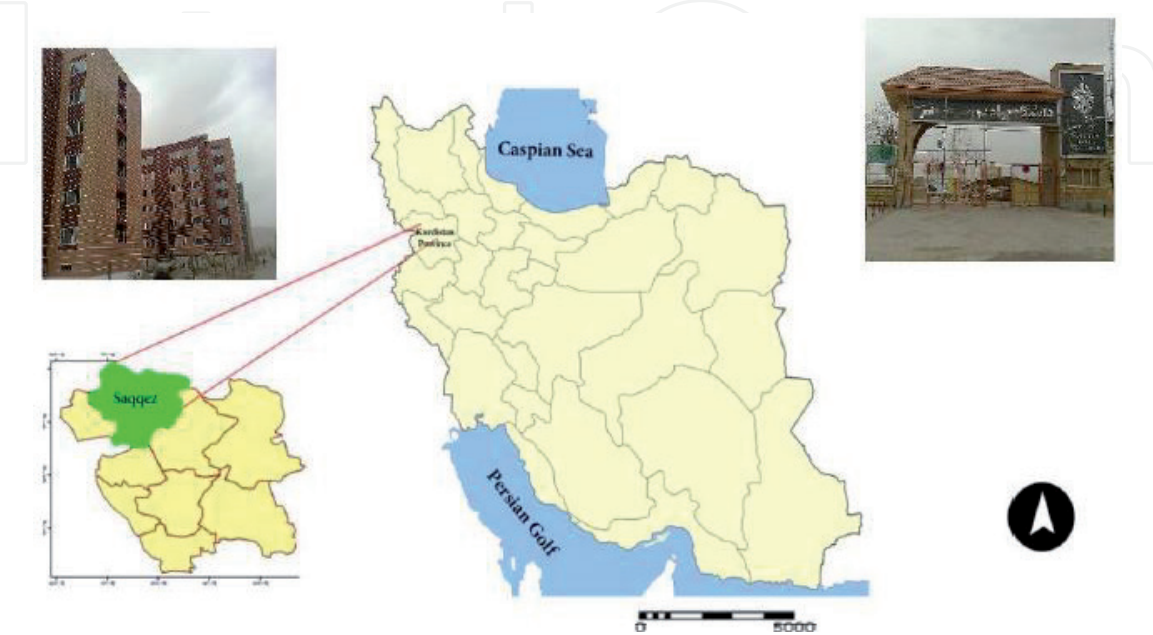


Figure 1.
The study area.

to the widespread destruction of environmental foundations, the life continuing in the neighboring cities of this area will be faced with the serious challenges. This will be understandable once we know that Saqqez city has covered about 500,000 people by providing the needed services and at the time of environmental crisis, there will be major human and natural challenges. Also, there are many examples of these type issues in the Asian cities. Therefore, the analysis of the environmental status of Saqqez city can be a suitable model for analyzing and adopting its findings to the other cities in the developing countries of Asia. According to what was stated the present research has the most important for the study area.

3. Material and methods

The applied methodology was analytical based on its nature and practical in term of results. In addition, descriptive-analytical studies, document and questionnaire in the framework of Delphi, and cross-impact matrix analysis were employed using Micmac and scenario wizard software tools. In the first step, after collection of data and identification of basic variables in the Delphi model, 50 questionnaires were distributed among 30 municipal executives and 20 academic elites with expertise and experience in urban management and environmental issues. Data were analyzed with a 78×78 matrix, by which data were included into the cross impact matrix followed by closing the CIM. After this classification, the experts were asked to evaluate the affecting variables (direct, indirect or potential) by scoring 0–3 with p values (0 = null, 1 = weak, 2 = average, 3 = strong, P = potential effect). Finally, a list of variables was obtained as the key driving forces, which were incorporated in the amidst cross impact method in the form of a scenario planning software. At this point, the expert can only describe the hypothesis realization probability on a scale from 1 to 5 (weak to high probability), hence avoiding any lack of precision on the expert's side. It is more helpful to see all as conditional probabilities, that is, the realization of a hypothesis in relation to other ones. Score 6 means the hypothesis is independent. Measuring the direct and indirect influence of variables was not just in the Delphi model framework, but, at the same time, to measure the various dimensions of the impact-dependence of each variable (obvious and hidden layers), it has been used for the strategically related software.

4. Results and discussion

The effective environmental indicators of Saqqez city were classified in the framework of a $n \times n$ matrix. For this purpose, 16 main categories of variables (**Table 1**) along with the 78 subcommittee variables were identified as the primary variables after holding meetings with the selected academics and executives. Then, by incorporating the variables into the mic mac software, it was attempted to define each variable according to its subsidiary and identity. In the next step, the experts were asked to score the variables based on the influence and effectiveness rate of variables on each other. As stated in the methodology section the variables were scored from 0 to 3 with P values (0 = null, 1 = weak, 2 = average, 3 = strong, P = potential effect), forming a cross impact matrix (**Figure 2**). It should be noted that due to the large size, only some parts of the matrix are expressed in here.

Based on the above findings, it can be concluded that the obtained fill rate is equal to 95.79% with two data iterations, representing a high level of variables influencing each other. This situation shows the efficiency of the research tool and also a very desirable verification of data collection by distributing the questionnaires.

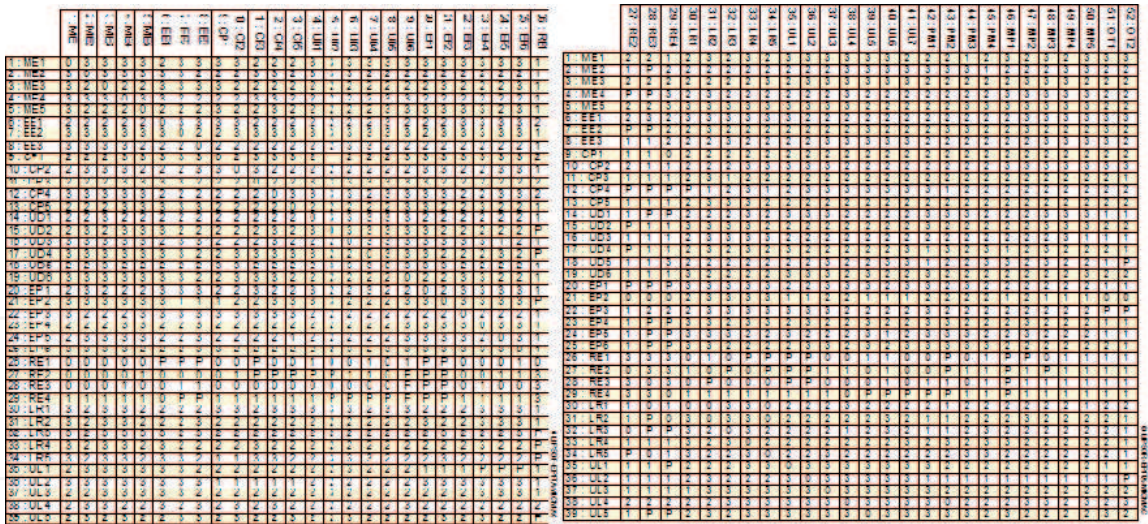


Figure 2.
A small part of CIM on urban environment in the study area. Source: Research findings, 2018.

Afterwards, CIM was obtained based on **Table 1**. Since a total of 5828 values were calculated in the framework of the cross-impact matrix by the elites, 2937 cases with the highest statistical volume had a moderate impact (2) on other variables: Also, 1939 numbers had the highest impact, and 797,256 and 155 cases presented ordinary the lowest, null and potential impacts on the other variables. **Table 1** provides the categorized variables belonging to the number of abbreviated variables.

According to **Tables 1** and **2** and also by considering the analytical results, there are different practically important variables in Saqqez environmental system. **Table 3** shows various forms of the variables in the framework of determinant, result, planar and independent variables.

Figure 3 and **Tables 1–3** clarify that the religious element had the lowest influence and dependency coefficient among other variables. Also, according to calculated column rates, the management elements (ME), new technologies (NT) and recycling (RY) had the most direct dependency to other research variables. Therefore, codification and promotion of urban recycling regulation index (RY4) with 211 scores and that of urban environmental diplomacy project (ME5) with 197 scores had the most direct impacts on the other variables. The integrated urban environmental management index (ME4) with the 188 column rates showed the highest indirect impact among other research variables (**Table 2**).

The research variables are distributed in the diagram according to the variable status in the analyses and the planar identity of some other variables. Paying attention to the findings presented in **Figures 4** and **5** can be illustrated as below.

Therefore, the instability situation of Saqqez urban environment system was confirmed at a high level through the obtained data from the analysis of indirect influences of the variables on each other, suggesting that the variables are more distributed around diagonal lines in the northeast and southeast parts of the diagram. Thus, most variables of this section have a planar identity, which, at the same time, are very influential and impressionable resulting from exacerbating or damping effects of variations due to their instable nature. Accordingly, the variables with the highest indirect impacts on the other variables include RY5 (attention to recycling economic value on the environmental management), UL7 (investment for the development of environmental land uses), RY3 (recycling of raw materials), ME5 (codification of environmental policy projects) and UL6 (biological and ecological resource management) with row points of 5,256,577, 5,194,741, 5,177,374, 5,165,320 and 5,099,651, respectively. Meanwhile, the indexes of urban integrated

Matrix size	Iteration	0 (N)	1 (N)	2 (N)	3 (N)	P (N)	Total	Fill rate
78 × 78	2	256	797	2937	1939	155	5828	95.7924%

Source: Research findings, 2018.

Table 1.
The features of primary matrix.

	Categories	Abbreviation	Variables	The highest row rates	The highest column rates
1	Ecological variables	EV	EV1 & EV2	EV2: 151	EV1: 182
2	Urban recycling	RY	RY1 to RY5	RY4: 211	RY4: 185
3	New technologies	NT	NT1 & NT2	NT2: 189	NT2: 185
4	Sociocultural	CS	CS1 to CS7	CS7:155	CS7: 168
5	Management elements	ME	ME1 to ME5	ME5: 197	ME4: 188
6	Physical-spatial	PS	PS1 to PS7	PS1: 171	PS7: 162
7	Old texture	OT	OT1 to OT5	OT2: 191	OT5: 142
8	Marginalization and poverty	MP	MP1 to MP5	MP2: 183	MP4: 172
9	Population and immigration	PM	PM1 to PM4	PM4: 191	PM1: 167
10	Urban land use	UL	UL1 to UL 7	UL7: 192	UL1: 173
11	Environmental rules	LR	LR1 to LR5	LR1: 158	LR4: 181
12	Religious elements	RE	RE1 to RE4	RE4: 55	RE4: 92
13	Environmental pollutants	EP	EP1 to EP6	EP7: 173	EP4: 173
14	Urban diversity	UD	UD1 to UD6	UD6: 178	UD6: 168
15	Climate parameters	EP	CP1 to CP5	CP2: 184	CP4: 171
16	Economic elements	EE	EE1 to EE3	EE2: 188	EE1: 165

Source: Research findings, 2018.

Table 2.
Variables of urban environment in the study area.

environmental management (ME4), compliance of Saqqez city environmental policies with the 1404 (2025) Iranian strategic planning (ME3) and the codification of environmental policy project (ME5) with column points of 5,020,651, 4,965,982 and 4,887,829 presented the highest indirect dependencies among the other variants.

Variables				
	Determinant	Result	Planar	Independent
1	OT	Creating urban environment integrated plan (ME1)	Climate parameters (CP)	Religious element (RE)
2	RY	The impossibility of establishing urban parks and green open spaces (OT2)	Environment pollution (EP)	—
3	ME	Lack of sense to place due to the immigrant citizens (OT4)	Urban land use (UL)	—
4	NT	Physical-spatial design according to UE (PS2)	Ecological variables (EV)	—
5	—	Non-standard density of housing units and population (PS3)	Urban diversity (UD)	—
6	—	Utilizing of social and cultural capacity in the UE (CS1)	Environment rules (LR)	—
7	—	Originality and environmental belongings in the metropolitan area (CS5)	Marginalization and population elements (MP)	—
8	—	Correct biological and ecological resource management (UD6)	—	—
9	—	Resource allocation and creation of new bio-capacities (EE2)	—	—

Source: Research findings, 2018.

Table 3.
Different research variables according to their identity.

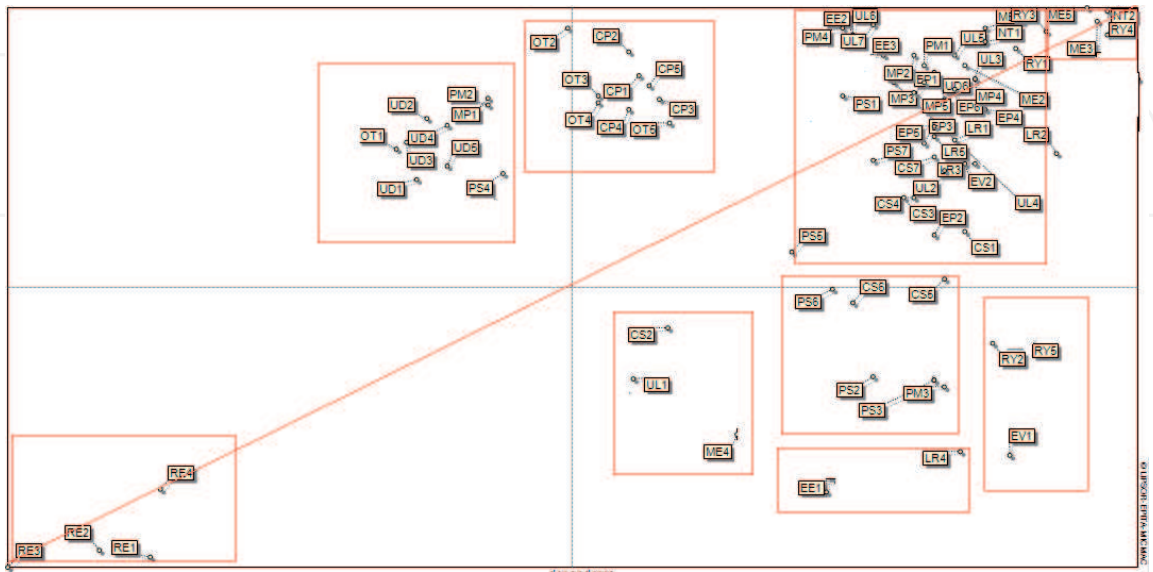


Figure 3.
Distribution of variables according to direct influence-dependency and their planar identity. Source: Research findings, 2018.

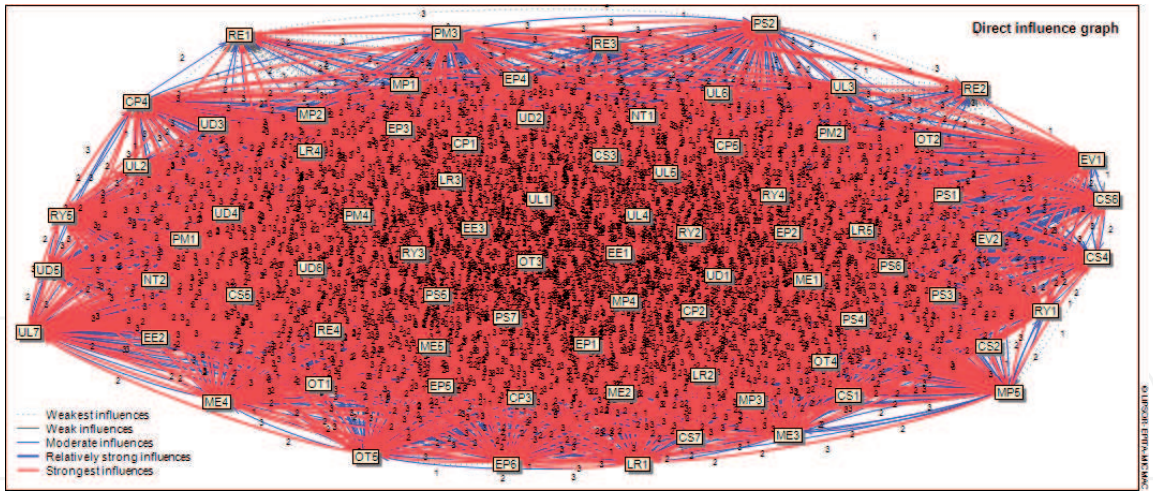


Figure 4.
Distribution of variables according to their direct influence-dependency. Source: Research findings, 2018.

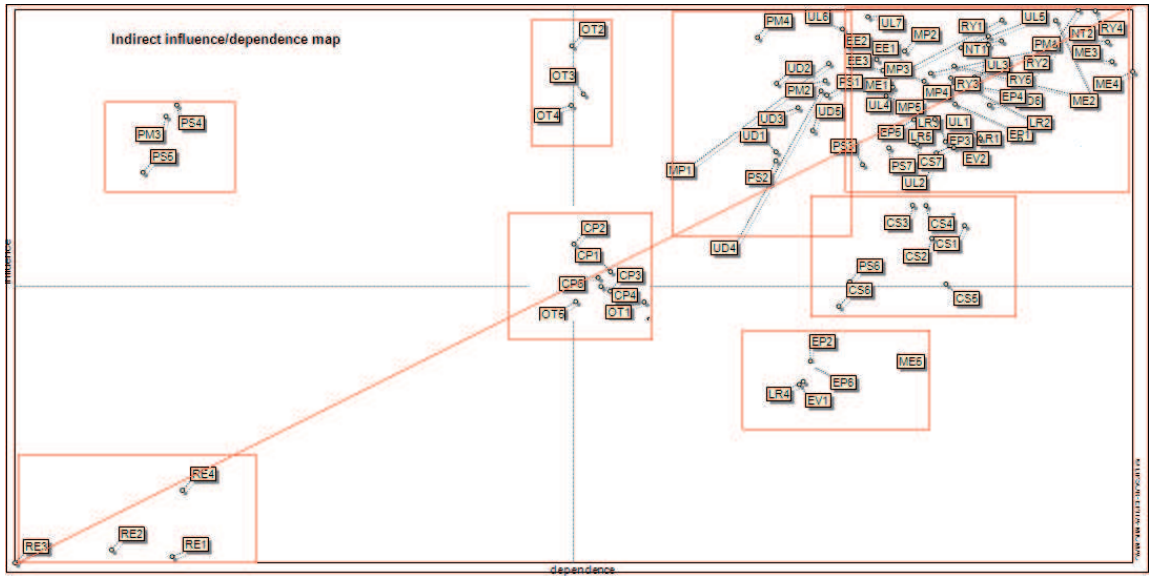


Figure 5.
Distribution of variables according to indirect influence-dependency. Source: Research findings, 2018.

According to the findings of this research, it is obvious that R^2 coefficient is equal to 0.0909 with a trend line value of 0.43 indicating strength relationships among the selected variables in the improvement of the urban environment in Saqqez city. Therefore, attention to the recycling of goods and waste materials with 3 weights and 0.04 coefficients besides the waste separation (Co: 0.03 & We: 4, final weight 0.12) cause lesser damages to the urban environment. Thence, the key driving forces in Saqqez urban environment are presented in **Table 4**.

By incorporating the key forces of the urban environment in the study area to the amidst cross impact methods in the frame of SMIC software, the key forces can be defined as four assumptions of consistent scenario (CS), middle scenario (MS), weal scenario (WS) and inconsistent scenario (IS). These assumptions in the form of a questionnaire were sent to 25 experts to assess their relationships by scoring from 1 to 5. Here, the expert can only describe the hypothesis realization probability on a scale from 1 to 5 (weak to high probability), hence avoiding any lack of precision from the expert's side. It is more helpful to see all as conditional

Key direct influencing factors	Abbreviation	Key indirect influencing factors	Abbreviation
Urban recycling	RY	Urban recycling	RY
Management environment	ME	Urban land use	UL
Urban land use	UL	Management environment	ME
Population and immigration	PM	Economic elements	EE
Old texture	OT	Climate parameters	CP
New technologies	NT	Urban diversity	UD
Environmental pollutants	EP	Marginalization and poverty	MP
Economic elements	EE	Old texture	OT
Climate parameters	CP	Population and immigration	PM
Ecological variables	EV	Environmental pollutants	EP
Urban diversity	UD	New technologies	NT
Environmental rules	LR	Physical-spatial	PS
Marginalization and poverty	MP	Ecological variables	EV
Physical-spatial	PS	Sociocultural	CS
Sociocultural	CS	Environmental rules	LR
Religious elements	RE	Religious elements	RE

Source: Research findings, 2018.

Table 4.
The key affecting variables in Saqqez environmental management.

probabilities, that is, the realization of a hypothesis in relation to the rest. Score 6 means that the hypothesis is independent. The software first produces a solution, namely a median probability distribution of a set of hypotheses. Minimizing its quadratic form, this is the least remote equally probable solution which would give each scenario the same probability. On the other hand, there exist certain solutions in Π tending to infinity, which give extreme values to each scenario. For the first eight extremes, the software calculates the uncertainty range: minimum and maximum values that can be taken by each scenario. Prob-Expert provides a series $(\pi_1, \pi_2, \dots, \pi_r)$ of r scenarios per expert, which affects the highest value of the most probable scenario.

As shown in **Table 5**, the influence and dependence between different scenarios can be obtained in the views of experts. It should be noted that the second assumption in the frame of the second scenario has the highest influence rate on another scenario and the inconsistent scenario has the lowest influence on other situations. In contrast to this case, the last scenario (IS) had the uppermost dependency to the other scenarios. According to overall approach of the research, it can be concluded that after identification of variables and assessments of their relationships by the selected executives and academic elites, a total of 78 final variables were evaluated in the framework of TNS approach key assumptions. Finally, 16 variables were selected as the key influencing and effective forces (**Table 4**). In addition, due to the proximity of some research indices to each other, these parameters were used in the context of a supplementary variable to the scenario planning process. Also, to complete the requirements of the scenario, some indices were added to the previous list and applied in the process of favorable, tragic and middle scenarios. Considering the courses of strategic planning (5–10, 10–20 and over 30 years as the short-, as medium- and the long-term periods), this research has considered the 15-year study period to explain the future study approach in Saqqez urban (**Table 6**).

	Scenarios	1 - 1	2 - Ensemble des exp
►	01 - 1111	0.338	0.338
	02 - 1110	0.196	0.196
	03 - 1101	0.072	0.072
	04 - 1100	0.052	0.052
	05 - 1011	0.084	0.084
	06 - 1010	0.035	0.035
	07 - 1001	0.023	0.023
	08 - 1000	0.006	0.006
	09 - 0111	0.073	0.073
	10 - 0110	0.04	0.04
	11 - 0101	0.015	0.015
	12 - 0100	0.008	0.008
	13 - 0011	0.007	0.007
	14 - 0010	0.009	0.009
	15 - 0001	0.008	0.008
	16 - 0000	0.034	0.034

Table 5.
Extracted scenarios according to the probe-expert provides.

Favorable scenario	Tragedy scenario	Middle scenario	Key element
Taking the advanced technologies and IT to enhance the urban environment development capacity in Saqqez city	Lack the utilization of advanced technologies and information technologies (IT) to enhance the urban environment development capacity in Saqqez city	Continuation of the current situation	New technologies
Developing the recycling system and promotion of its laws by considering the recycling economic and environmental values at the highest possible level	Commercialization of environmental resources and lack of recycling system development	Intermediate stage in the commercialization and development of environmental systems	Urban recycling
Environmental development management through the codification of urban environmental rules and developing the strategies and promotion of urban environmental policy	Anti-environmental development, management through the lack of urban environmental rules	Continuation the current situation	Environmental management
The creation of sustainable land use patterns with the environmental nature	Instability of the urban environmental land use and their widespread destruction	The creation and development of urban environmental land uses with many shortcomings	Urban land use

Source: Research findings, 2018.

Table 6.
The status of key driving forces in Saqqez urban environment.

5. Conclusion and suggestions

According to the presented results, the reliability of research tool was measured through holding discussion meetings, developing the key assumptions and refining the questionnaire based on the elites' views. Therefore, it can be easily understood from the findings that the urban environment system in Saqqez city is faced with such a huge volatility that continuation of the current status will lead to the formation of disaster scenarios. In the best situation, if the current process continues, the urban environment will be accompanied by a widespread destruction. According to the cross matrix analysis, variables such as the management, migration, poverty, environmental and so on will be the basic resonator element of system transience in the absence of the correct uses of these variables. The research findings further signify that implementation of the foresight studies in the form of TNS approach can be an effective tool to measure the instability rate of the urban environment system in Saqqez city. According to the different parts of this research, it should be noted that solving the environmental problems of Saqqez city depends on the use of foreseeable approaches in the context of environmental models. Thus, different approaches to the achievement of sustainable urban development model in the urban environment scale will be provided using short-, medium- and long-term strategies, as well as by planning and monitoring the implementation of such strategies. To do this, the fundamental solution to prevent environmental degradation in Saqqez metropolis is to think deeply and to have a commercialization view of the space as well as a sustainable spatial attitude towards long-term sustainable approaches. Based on the results from all extracted data in the analysis process, the value of internal factors (IFE), external factors (EFE) and weaknesses, strengths, opportunities and threat matrix, can be presented as **Figure 5**. The following propositions are presented as some safe ways:

- Preparing the urban environmental strategic plan with attention to the urban nature-oriented approaches
- Rebalancing the urban environment's capacity and the citizen uses
- Giving more roles to the citizens for improving the urban environment indicators
- Developing local and regional urban recycling centers through long-term plans
- Giving more importance to the direct and indirect impacts on the developing environmental scenarios
- Trying to achieve the optimal scenarios for effective management of the urban environment

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