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DETERMINATION OF CRITICAL VARIABLES FOR RESILIENT URBANIZATION

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Abstract: As society urbanizes in economic, political, demographic, and sociological terms, living spaces, buildings, streets, avenues, and facilities must also physically adapt to urbanization and form resilient urbanization. The 11. goal of Sustainable Development Goals is defined as "Sustainable Cities and Communities". The goal of this target is to "Make cities and human settlements inclusive, safe, resilient, and sustainable". This target once again highlights the importance of sustainable and resilient cities and urbanization. This study was conducted to identify the fundamental and critical variables in resilient urbanization. In this study, a comprehensive literature review was conducted for resilient urbanization, identifying 11 key and 22 critical variables. Semi-structured questionnaire was designed for the 11 key variables, while structured questionnaire was developed for the 22 critical variables. Firstly, the hierarchical relationships among 11 key variables were identified using Interpretive Structural Modeling (ISM). Subsequently, the importance levels of 22 critical variables were identified through Cronbach's alpha (α), frequency, and relative importance index (RII) analyses. According to the hierarchical structural modeling, the process that begins with uncontrolled migration concludes with urban transformation. Statistical analysis results have determined that one of the most significant causes of squatting and illegal construction is the lack of supervision. Additionally, the results indicate that squatting and illegal construction render cities vulnerable to natural disasters.

Keywords: Resilient urbanization, Sustainable urbanization, Sustainable development goals, Sustainable cities

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1. Introduction

A city is a settlement where people carry out their economic, cultural, and social activities, live and work as a community, and where more opportunities are offered to people compared to rural areas. The urbanization of a settlement fundamentally occurs with an increase in its population, and consequently, its built environment, as well as its economic, cultural, and social opportunities (Susmaz and Ekinci, 2009). The main reasons for the development of cities can be attributed to the agricultural and industrial revolutions. The agricultural revolution led to the beginning of settled life and the formation of small settlements, while the industrial revolution caused migration from rural areas to cities due to mechanized production. These migration movements also accelerated urbanization. Agricultural mechanization has led to unemployment in rural areas, while industrialization has increased the demand for labor in urban areas (Kayan, 2012). Urban transformation refers to activities where all emerging problems of a developing city, including social, economic, physical, environmental, climatic, and so on, are addressed, and comprehensive solutions are generated for these issues over time (Thomas, 2003). The concepts of city and urbanization should not be evaluated unilaterally but should be considered from economic, political, demographic, and sociological perspectives. As society urbanizes economically, politically, demographically, and sociologically, it must also geographically urbanize with its structures, streets, avenues, and facilities physically adapting to urbanization. Up to the present, many researchers have recognized the importance of urbanization and the practices within the urbanization process, conducting various studies on these topics. These studies are categorized and summarized below according to their subjects. Işık (2005), Susmaz and Ekinci (2009), Esen (2023) and Küçükdağ (2023) have worked on urbanization. In his study, Işık (2005) examined the urbanization models in Türkiye caused by industry, tourism, and terrorism. Susmaz and Ekinci (2009) focused on healthy urbanization. This study identified the processes leading to unhealthy urbanization and provided solutions based on the role of local governments. In his study, Esen (2023) evaluated disaster-resistant cities around the world and provided an assessment for Türkiye. Küçükdağ (2023) focused on the impact of migrations on urbanization. Torlak (2003), TMMOB (2004) and Keleş (2023) have worked on slums and illegal constructions. Torlak (2003) conducted a study on the history and process of slum development in Türkiye, also covering the zoning amnesties enacted during this process. The report prepared by TMMOB Urbanization and Local Governments Working Group

(2004) addressed the issue of illegal construction. The report concluded that the housing need triggered by intense migration to cities and the zoning amnesties enacted due to illegal constructions were caused by a lack of control mechanisms and the pursuit of profit. Keleş (2023) investigated the impact of slum development and zoning amnesties on zoning plans in Türkiye. Meşhur (2008), Usta (2021), Inceyol (2021) and Çay and Kandemir (2022) addressed zoning plans and regulations in their studies. Meşhur (2008) analyzed the stages of preparing the subdivision plan that ensures the implementation of the urban zoning plan in the field. Usta (2021) examined the relationship between zoning plans and urban rent. Inceyol (2021) evaluated the implementation of zoning plan changes through examples. Çay and Kandemir (2022) addressed the changes made in Türkiye's zoning regulations. Erbaş (2018), Kasparoğu and Suri (2019), and Bulubay (2021) examined the 2018 zoning amnesty regulation. Erbaş (2018) investigated the impact of the zoning amnesty process on the present and future of cities. Kasparoğlu and Suri (2019) analyzed the zoning amnesty regulation in all aspects and provided recommendations for the legal, economic, and social conditions necessary for resilient urbanization. Bulubay (2021) conducted an evaluation specifically for Istanbul's historic peninsula. Genç (2008), Karabulut (2019) and Çakır (2023) have worked on urban transformation. Genç (2008) identified the reasons for the need for urban transformation in Türkiye and examined the implementation processes. Karabulut (2019) evaluated urban transformation from legal and social perspectives. Çakır (2023) addressed the deficiencies and problematic aspects of urban transformation projects according to current conditions, highlighting the problems and time losses in urban transformation projects in Istanbul. Incorrect and incomplete practices in urbanization processes make cities vulnerable to disasters. An excess of slums without engineering services, illegal constructions lacking engineering services, and structures that have outlived their economic lifespan reduce the disaster resilience of cities, leading to significant loss of life and property when disasters occur. The importance of resilient urbanization was better understood following the significant losses caused by the 1999 Gölcük and Düzce Earthquakes in our country. The recent Pazarcik and Elbistan earthquakes have also highlighted the importance of resilient urbanization. Additionally, the goal of creating sustainable cities and communities is also included among Türkiye's Sustainable Development Goals. Among the main targets of this goal is “By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels” (T.C. Cumhurbaşkanlığı Strateji ve Bütçe Başkanlığı, 2019). The aim of this study is to list the fundamental and critical variables in resilient urbanization in Türkiye based on a literature review, reveal the hierarchical structure of the relationships among these key variables, and rank the critical variables by their significance.

2. Materials and Methods

The loss of lives and property caused by natural disasters highlights the importance of resilient urbanization. However, a range of variables hinder the successful implementation of urbanization. In this context, the aim of this study is to list the fundamental and critical variables in resilient urbanization based on a literature review, reveal the hierarchical structure of the relationships among these key variables, and rank the critical variables by their significance. This study consists of four stages. The first stage involves identifying the fundamental and critical variables based on the literature, the second stage focuses on the preparation and administration of the questionnaire, the third stage entails developing an interpretive model for the fundamental variables, and the final stage includes performing statistical analyses for the critical variables and establishing their order of importance.

2.1. Identifying the Fundamental and Critical Variables

In the first stage, a literature review was conducted to create a comprehensive list of variables shown in Table 1 and Figure 1.

2.2. Creation of the Questionnaire

In the second stage, two questionnaires, one semi-structured and the structured, were prepared based on the variable list. In the semi-structured questionnaire, the fundamental variables were designed in accordance with the Interpretive Structural Model, while the structured questionnaire was prepared for critical variables. The structured questionnaire used a 5-point Likert Scale, with importance levels structured as "1=Not at all important, 2= Somewhat important, 3= Moderately important, 4= Very important, 5= Extremely important”. The semi-structured questionnaire was administered to 4 experts, while the structured questionnaire was conducted with 160 experts in the field of urbanization.

2.3. Interpretive Structural Model

In the third stage, the relationship between the key variables has been determined through Interpretive Structural Modeling (ISM). Interpretive Structural Modeling first categorizes the influential factors in a problem, constructs a layered hierarchical model, and determines the solution to the problem. In other words, this method is used to identify the effects of factors on other factors (Çankaya, 2022; Sağlam, 2023). This method not only identifies direct relationships but also incorporates indirect relationships into the solution (You et al., 2024). Through this approach, the problem becomes defined, simplified, and interpretable (Raut et al., 2017; Sağlam, 2023). The first step in interpretive structural modeling (ISM) analyses is determining the contextual

relationships. In this relationship: Y indicates that variable i unidirectionally affects variable j; Z indicates that variable j unidirectionally affects variable i; X indicates that variables i and j mutually affect each other; O indicates that variables i and j do not affect each other. After this step, the indirect relationships are determined, and the Reachability Matrix is created, where a value of 0 is assigned for O, and a value of 1 is assigned for X, Y, and Z. Later, For Level Partition, the Reachability Set (i), Antecedent Set (j), and their Intersection are determined. Finally, the mutual relationships are determined (Tan et al., 2019).

Table 1. Naming of fundamental and critical variables (Çakmak, 2024)

ID	Fundamental variables	ID	Critical variables
E1	Uncontrolled migration	D1	One of the main causes of slum development and illegal construction may be uncontrolled migrations.
E2-E3	Slums Illegal construction	D2	One of the most important reasons for illegal construction and slum development could be the inability to carry out inspections effectively and on time.
		D4	Settlements formed by slums and illegal structures can make it difficult to create ideal urban plans.
		D5	Settlements formed by slum and illegal construction may be vulnerable to disasters, especially earthquakes.
E4	Unplanned/unplanned urbanization	D3	One of the main reasons for unplanned/irregular urbanization could be the slum development and illegal construction that emerged after uncontrolled migration from rural areas to cities due to industrialization.
E5	Confusion of zoning legislation	D20	Due to issues encountered in the zoning process and the fragmented and complex nature of the legislation, there may be a need for a new approach to spatial planning.
E6	Zoning amnesty/peace regulations	D6	Zoning amnesties/regulations can be defined as legal arrangements that are forced to be introduced at the end of slum and illegal construction processes.
		D7	Zoning amnesty/regulations may lead to the perception of 'another zoning amnesty will be issued' and, as a result, an increase in the tendency towards slum development and illegal construction.
		D8	Zoning amnesty/regulations may cause an increase in slums and illegal structures.
		D9	Zoning amnesty/regulations may not have provided a solution to the problem of slum development and illegal construction.
		D10	Rather than contributing to the solution of urbanization and zoning problems, zoning amnesty/regulations may cause the deterioration of the current situation.
		D11	Structures included in the zoning amnesty/regulations may not be resistant to disasters, especially earthquakes.
		D12	Zoning amnesty/regulations may lead to the creation of vulnerable cities.
		D13	In order to form disaster-resistant, ideal cities, it may be appropriate not to implement legal arrangements such as zoning amnesty.
		D14	Zoning amnesty/regulations may make it difficult to implement urban plans.
		D16	The most recent zoning amnesty regulation can be considered appropriate in terms of identifying unregistered structures that violate zoning laws.
		D17	The zoning amnesty has become a regulation that registers illegal structures and enables the identification of places and buildings that can be subject to urban transformation.
E7	Zoning penalties not being implemented/not being implemented	D15	Zoning amnesty/regulations may have allowed the resolution of zoning problems, generated income for the state, and provided solutions to construction projects subject to demolition or fines.
E8	Subdivision plans not being made/not being made	D21	More attention by the relevant municipalities to the preparation of parceling plans, as required by Article 5/12 of "Planlı Alanlar Imar Yonetmeligi" for construction, could be the right approach for achieving ideal urbanization.
E9	Ideal city plans not being made/not being made	D18	For a city to be planned and grow properly, it is possible through the preparation of plans in accordance with proper and long-term planning criteria and adhering to these plans except in unavoidable circumstances.
E10	Changes in city plans	D19	Frequent changes made to the city's plans may cause a deviation from the original purposes of the plans
E11	Urban transformation	D22	In Türkiye, the renewal of unplanned/irregular and vulnerable cities through urban transformation practices may be a necessary application.

	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21	D22
Torlak, 2003			x				x															
Susmaz ve Ekinci, 2009	x																					
Uzuncibuk, 2009				x															x			
Karabel, 2014				x					x		x											
Planlı Alanlar Imar Yönetmeliği., 2017																					x	
Erbaş, 2018;									x			x	x									
Akalın, 2018	x		x							x								x				
Özelmacıklı ve Baz, 2018																x						
Özlüer, 2018;															x		x					
Tercan, 2018					x	x		x														
Kasparoğlu ve Suri, 2019											x	x				x	x					
Bulubay, 2021		x			x	x			x					x								
Inceyol, 2021																		x	x			
Turhan, 2021															x							
Usta, 2021																			x			
Uysal, 2021	x																					
Esen, 2023																				x		
Keleş, 2023		x	x	x	x	x	x	x	x	x			x	x						x		
Köse et al., 2023				x																		x
Erdoğan and Babaoğlu, 2024																						x

Figure 1. Critical variables in the Urbanization Process (Çakmak, 2024).

2.4. Statistical Analyses

In the final stage, the data set was evaluated using statistical analyses. These analyses consist of three stages. In the first analysis stage, general information about the participants was gathered; in the second stage, frequency analysis was conducted; and in the third stage, the Relative Importance Index (RII) analysis was applied to rank the critical variables in implementing resilient urbanization. The questionnaire contains questions related to the 22 critical variables grouped under 4 main variables (Table 1). A data set was created based on the responses of the 160 questionnaire participants to these questions, and statistical analyses were conducted using this data set. The applied analyses include Cronbach's alpha (α), frequency analysis, and Relative Importance Index (RII) analysis. SPSS 29.0.2.0 was used for the analyses. The first analysis conducted was the Cronbach's alpha (α) analysis, which aims to determine the reliability of the questionnaire. As the Cronbach's alpha value approaches 1, the reliability of the questionnaire increases (Yockey, 2016). A Cronbach's alpha (α) value greater than 0.60 is considered good, while a value greater than 0.80 is considered excellent (Cronbach, 1951; Abbasianjahromi et al., 2019; Elmalı and Bayram, 2022). The second analysis is frequency analysis. This analysis shows how many measurements were taken for each measurement (Arıcı, 1998). The frequency analysis results obtained from the frequency analysis are also used in the Relative Importance Index (RII) Analysis. The final analysis method applied in the study is the Relative Importance Index (RII). This method allows for determining the importance index of each factor on a specific scale and comparing it with other factors (Naji, et al., 2022; Youssefi and Çelik, 2023). This method has been applied by many researchers in their past studies related to the construction sector, and it has been found to be an effective method for ranking variables (Kometa et al., 1994; Sambasivan and Soon, 2007; Gündüz et al., 2013, Alaloul et al., 2020; Demirkesen and Tezel, 2021; Elmalı, and Bayram, 2022). In the context of the study, the Relative Importance Index (RII) for each identified variable was computed individually in accordance with Equation (1) presented below.

$$RII = \frac{((5 * X5) + (4 * X4) + (3 * X3) + (2 * X2) + (1 * X1))}{Q * N} \quad (1)$$

In the equation; RII represents the relative importance index, X represents the frequency analysis results, Q represents the highest level of importance, and N represents the total number of questionnaires.

3. Results

In this context, the results of semi-structured and structured questionnaires, interpretive structural modeling, and statistical analyses are presented in order. The semi-structured questionnaire was conducted by

obtaining the opinions of four experts. Detailed information about the experts is provided in Table 2. The first section of the structured questionnaire includes general information about the participants, such as their education level, experience, position within the company, and expertise. Of the participants, 43.12% are civil engineers, 15.00% are urban and regional planning experts, and 14.38% are architects. Regarding education, 59.38% of the participants have a bachelor's degree, 30.62% have a master's degree, and 6.25% have a doctoral degree. In terms of experience, 14.38% of the participants have more than 20 years of experience, 17.50% have 16 to 20 years of experience, and 36.88% have 11 to 15 years of experience. Regarding their employment, 51.88% work in municipalities, 11.25% work in ministries or directorates affiliated with ministries, and 32.50% work in the private sector. Detailed information about the participants is provided in Table 2. The first step in interpretive structural modeling (ISM) analyses is determining the contextual relationships. According to the authors, contextual relationships among the eleven variables are established and presented in Table 3. In the next step, the Reachability Matrix is created and presented in Table 4.

Table 2. The properties of the respondents

	Categories		Percentage (%)
Semi-structured questionnaire	Departments where participants received training	Civil Engineering	75.00
		Architecture	25.00
	Educational status of participants received questionnaire	Master's degree	75.00
		Bachelor's degree	25.00
	Working periods of participants in the construction sector	11-15 years	50.00
		6-10 years	50.00
Structured questionnaire	Departments where participants received training	Civil Engineering	43.12
		City Regional Planning	15.00
		Architecture	14.38
		Topographical Engineer	12.50
		Technician	6.25
		Others	8.75
	Educational status of participants received questionnaire	Doctorate degree	6.25
		Master's degree	30.62
		Bachelor's degree	59.38
		Associate degree	3.75
	Working periods of participants in the construction sector	More than 20 years	14.38
		16-20 years	17.50
		11-15 years	36.88
		6-10 years	10.62
		0-5 years	20.62
	Institutions where participants work	Ministry or Directorates affiliated to the Ministry	11.25
		Municipality	51.88
		Private sector	32.50
		University	4.37

Table 3. Contextual relationships

	E11	E10	E9	E8	E7	E6	E5	E4	E3	E2
E1	Y	O	Y	Y	O	Y	Y	Y	Y	Y
E2	Y	O	Y	Y	X	X	Y	Y	Y	
E3	Y	O	Y	Y	X	X	Y	Y		
E4	Y	X	Y	X	Z	X	Z			
E5	Y	Y	Y	Y	O	O				
E6	Y	Y	X	Y	Y					
E7	Y	O	O	O						
E8	Y	Y	Z							
E9	Y	X								
E10	Y									

E1=Uncontrolled migration, E2= Slums, E3= Illegal construction, E4= Unplanned/unplanned urbanization, E5= Confusion of zoning legislation, E6 Zoning amnesty/peace regulations, E7= Zoning penalties not being implemented/not being implemented, E8= Subdivision plans not being made/not being made, E9= Ideal city plans not being made/not being made, E10= Changes in city plans, E11= Urban transformation.

Table 4. Reachability matrix

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11
E1	1	1	1	1	1	1	1	1	1	1	1
E2	0	1	1	1	1	1	1	1	1	1	1
E3	0	1	1	1	1	1	1	1	1	0	1
E4	0	1	1	1	0	1	1	1	1	1	1
E5	0	0	0	1	1	1	0	1	1	1	1
E6	0	1	1	1	1	1	1	1	1	1	1
E7	0	1	1	1	1	1	1	1	1	0	1
E8	0	1	1	1	0	1	1	1	1	1	1
E9	0	1	1	1	0	1	1	1	1	1	1
E10	0	0	0	1	0	1	0	1	1	1	1
E11	0	0	0	0	0	0	0	0	0	0	1

E1=Uncontrolled migration, E2= Slums, E3= Illegal construction, E4= Unplanned/unplanned urbanization, E5= Confusion of zoning legislation, E6 Zoning amnesty/peace regulations, E7= Zoning penalties not being implemented/not being implemented, E8= Subdivision plans not being made/not being made, E9= Ideal city plans not being made/not being made, E10= Changes in city plans, E11= Urban transformation. Bold colors indicate indirect relationships.

In the third step of the analysis, the results of the level partitioning, determined by the Reachability Set, Antecedent Set, and their Intersection, are presented in Table 5. In the final step, the mutual relationships among the fundamental variables in Resilient Urbanization have been determined. This hierarchical relationship is shown in Figure 2. The first stage of this hierarchy is Uncontrolled Migration (E1), and the highest level is determined as Urban Transformation (E11). The interpretive structural modeling results show that the problematic processes, starting with “uncontrolled migration”, are followed by "Slums," "Illegal construction," and "Zoning penalties not being implemented/not enforced." At the next level, it was determined that the challenge "Confusion of zoning legislation" is followed by the variables "Unplanned/poor urbanization," "Zoning amnesty/peace regulations," " Subdivision plans not being made/not implemented," "Ideal city plans not being made/not implemented," and "Changes in city plans." At the highest level of this hierarchical structure, "Urban transformation" has been identified. This challenge model, which starts with uncontrolled migration, shows that urban transformation is at the highest level.

Table 5. Results of level partitions

ID	Reachability Set	Antecedent Set	Intersection	Level
E1	E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11	E1	E1	5
E2	E2, E3, E4, E5, E6, E7, E8, E9, E10, E11	E1, E2, E3, E4, E6, E7, E8, E9,	E2, E3, E4, E6, E7, E8, E9,	4
E3	E2, E3, E4, E5, E6, E7, E8, E9, E11	E1, E2, E3, E4, E6, E7, E8, E9	E2, E3, E4, E6, E7, E8, E9,	4
E4	E2, E3, E4, E6, E7, E8, E9, E10, E11	E1, E2, E3, E4, E5, E6, E7, E8, E9, E10	E2, E3, E4, E6, E7, E8, E9, E10	2
E5	E4, E5, E6, E8, E9, E10, E11	E1, E2, E3, E5, E6, E7	E5, E6	3
E6	E2, E3, E4, E5, E6, E7, E8, E9, E10, E11	E1, E2, E3, E4, E5, E6, E7, E8, E9, E10	E2, E3, E4, E5, E6, E7, E8, E9, E10	2
E7	E2, E3, E4, E5, E6, E7, E8, E9, E11	E1, E2, E3, E4, E6, E7, E8, E9	E2, E3, E4, E6, E7, E8, E9	4
E8	E2, E3, E4, E6, E7, E8, E9, E10, E11	E1, E2, E3, E4, E5, E6, E7, E8, E9, E10	E2, E3, E4, E6, E7, E8, E9, E10	2
E9	E2, E3, E4, E6, E7, E8, E9, E10, E11	E1, E2, E3, E4, E5, E6, E7, E8, E9, E10	E2, E3, E4, E6, E7, E8, E9, E10	2
E10	E4, E6, E8, E9, E10, E11	E1, E2, E4, E5, E6, E8, E9, E10	E6, E8, E9, E10	2
E11	E11	E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11	E11	1

E1=Uncontrolled migration, E2= Slums, E3= Illegal construction, E4= Unplanned/unplanned urbanization, E5= Confusion of zoning legislation, E6 Zoning amnesty/peace regulations, E7= Zoning penalties not being implemented/not being implemented, E8= Subdivision plans not being made/not being made, E9= Ideal city plans not being made/not being made, E10= Changes in city plans, E11= Urban transformation.

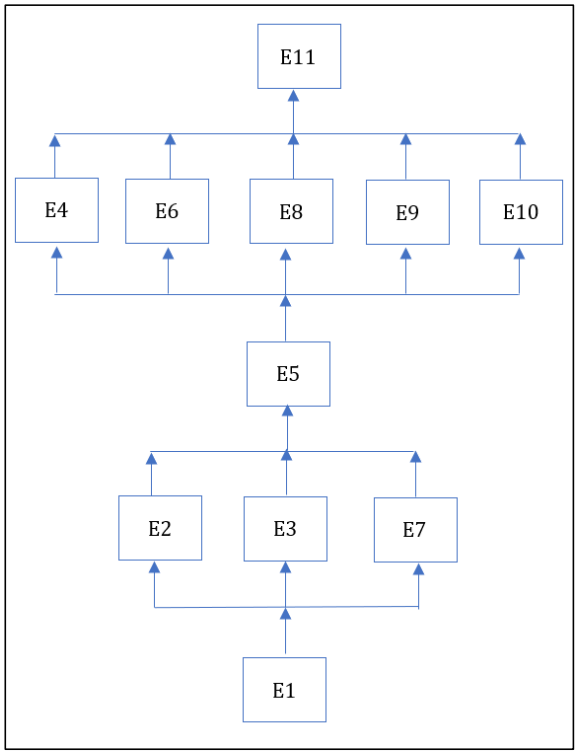

Figure 2. Interpretive structural modeling of fundamental variables for resilient urbanization.

In the fourth stage of the study, statistical analyses were performed using data identified through a questionnaire for the critical variables. These analyses include Cronbach's alpha (α), frequency, and Relative Importance Index (RII). The Cronbach's alpha (α) coefficient was determined to be 0.965. This value indicates that the questionnaire provides reliable results. The second analysis conducted in the stage is frequency analysis. The results of the frequency analysis for this study are shown in Table 6. The final analysis method applied in the stage is the Relative Importance Index (RII). The calculated RII results for this study are shown in Figure 3. In the Figure 3, values above 0.85 are identified as challenges of high importance and are highlighted in red. Variables with an importance level of 0.7 or higher are shown in blue, while those with lower importance are highlighted in yellow. According to this analysis results, "One of the most important reasons for illegal construction and slum development could be the inability to carry out inspections effectively and on time (D2)" and "Settlements formed by slum and illegal construction may be vulnerable to disasters, especially earthquakes (D5)" are variables with high importance. These variables are followed by " Zoning amnesty/regulations may lead to the perception of 'another zoning amnesty will be issued' and, as a result, an increase in the tendency towards slum development and illegal construction (D7)," " Structures included in the zoning amnesty/regulations may not be resistant to disasters, especially earthquakes (D11)" and "Zoning amnesty/regulations may lead to the creation of vulnerable cities (D12)".

Table 6. Frequency analysis results (%)

ID	Extremely Important	Very Important	Moderately Important	Somewhat Important	Not at all Important
D1	41.3	40.6	3.1	6.9	8.1
D2	60.0	28.8	1.3	3.1	6.9
D3	39.4	37.5	6.9	7.5	8.8
D4	54.4	31.9	1.9	3.8	8.1
D5	65.6	19.4	3.8	1.9	9.4
D6	23.8	26.3	9.4	19.4	21.3
D7	56.9	28.8	4.4	1.9	8.1
D8	53.1	31.9	3.8	4.4	6.9
D9	50.0	33.8	5.0	3.8	7.5
D10	53.8	30.0	4.4	4.4	7.5
D11	56.3	30.0	3.1	1.9	8.8
D12	56.3	30.6	3.1	1.3	8.8
D13	50.6	28.1	8.8	2.5	10.0
D14	53.1	29.4	3.8	4.4	9.4
D15	15.6	21.9	19.4	27.5	15.6
D16	10.6	23.1	18.8	26.9	20.6
D17	8.1	23.1	21.3	29.4	18.1
D18	61.3	23.8	3.8	3.1	8.1
D19	51.9	28.1	5.0	6.9	8.1
D20	33.1	38.1	15.0	5.0	8.8
D21	45.6	35.0	8.1	2.5	8.8
D22	52.5	29.4	3.8	5.0	9.4

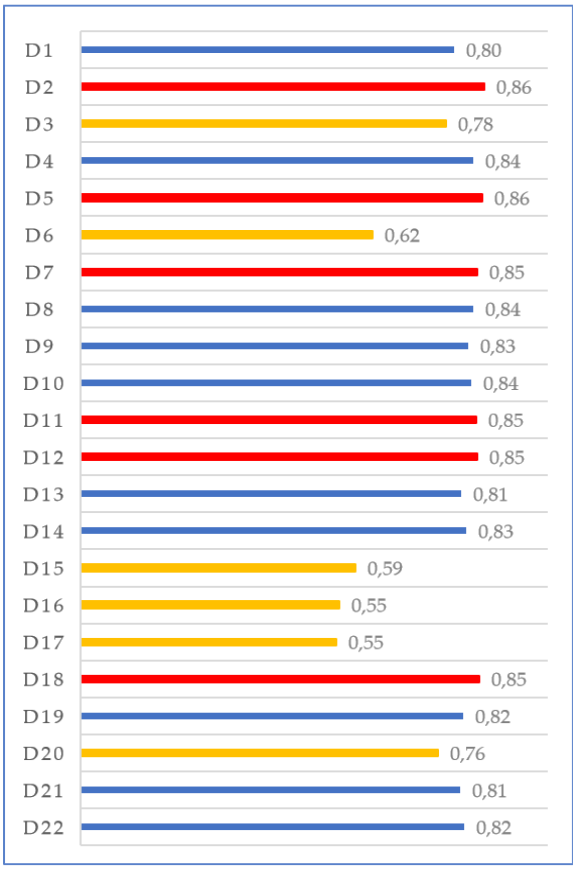

Figure 3. RII analysis results

"Zoning amnesty/regulations may have allowed the resolution of zoning problems, generated income for the state, and provided solutions to construction projects subject to demolition or fines (D15)", "The most recent zoning amnesty regulation can be considered appropriate in terms of identifying unregistered structures that violate zoning laws (D16)" and " The zoning amnesty has become a regulation that registers illegal structures and enables the identification of places and buildings that can be subject to urban transformation (D17)" are the critical variables with the lowest importance.

4. Discussion

This study was conducted to identify the key and critical variables in resilient urbanization. Initially, 11 key and 22 critical variables were identified and grouped for resilient urbanization in Türkiye. Subsequently, using interpretive structural modeling, the authors identified the hierarchical relationships among 11 key variables. The interpretive structural model obtained has identified migration as the first-tier variable for Resilient Urbanization. The literature includes publications that emphasize the interconnection between industrialization, migration, and urbanization. According to these studies, industrialization has led to an increase in rural-to-urban migration (Sağlam, 2006; Kasparoğlu and Suri, 2019). In the second tier of the interpretive structural model, the

variables "Zoning penalties not being implemented," "Slums," and "Illegal construction" are included. Studies emphasize that the primary cause of slums and illegal construction is migration. In other words, the housing demand that arises following rural-to-urban migration has led to the development of slums and illegal structures (Uşak and Yalçın, 2019; Tekinel and Güvercin, 2000; Küçükdağ, 2023). The subsequent tiers of the model include variables related to zoning (regulations and amnesty/reconciliation) and planning. At the final tier, urban transformation is positioned. These results support the findings of previous studies conducted on this subject. According to Günaydın (2015), the need for urban transformation projects in Türkiye emerges alongside urbanization problems, and the migration movements underlying this need have shaped the landscapes of today's cities. Subsequently, a questionnaire was designed for the 22 critical variables identified in this study and was administered to 160 experts. The data set created based on the questionnaire results was evaluated using statistical analyses, including Cronbach's alpha (α), frequency analysis, and the Relative Importance Index (RII). According to this analysis results, "One of the most important reasons for illegal construction and slum development could be the inability to carry out inspections effectively and on time (D2)" and "Settlements formed by slum and illegal construction may be vulnerable to disasters, especially earthquakes (D5)" are variables with high importance. According to Karabel (2014) slum development, illegal construction, and buildings that have reached the end of their economic lifespan are among the most significant issues, particularly in cities with high earthquake risk. Gezer (2014) has stated that most areas in need of urban transformation are slum zones. Additionally, according to Gezer (2014), another factor that increases the necessity for urban transformation in Türkiye is earthquakes.

5. Conclusion

In conclusion, the fundamental variables for Resilient Urbanization are listed in order as migration, slum development and illegal construction, issues and changes related to zoning, and issues and changes related to urban plans. At the top of this hierarchical structure lies urban transformation. Statistical analysis results have determined that one of the most significant causes of squatting and illegal construction is the lack of supervision. Additionally, the results indicate that squatting and illegal construction render cities vulnerable to natural disasters. This study has certain limitations. These limitations can include the sample set of questionnaire participants. Changes in the participant set may lead to relatively minor variations in the results.

Based on the results of this study, the following criteria are suggested for ideal urbanization:

- Prioritizing the implementation of urban transformation projects, especially in cities with low resilience.
- Ensuring the control of uncontrolled migration movements.
- Preventing construction that violates zoning regulations, such as slum development.
- Increasing inspections by relevant authorities and applying penal actions.
- Ensuring the preservation of ideal urbanization in zoning regulations.

Future studies could explore and compare the barriers to resilient urbanization in different countries.

Author Contributions

The percentages of the authors' contributions are presented below. All authors reviewed and approved the final version of the manuscript.

	M.E.Ç.	E.D.
C	60	40
D	60	40
S	40	60
DCP	60	40
DAI	60	40
L	60	40
W	60	40
CR	40	60
SR	30	70
PM	50	50

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to. The questionnaire survey procedures were approved by the Ethics Committee of Sakarya University, Sakarya, Türkiye (Approval date: 30.07.2024, protocol code: E-61923333-050.99-383795).

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