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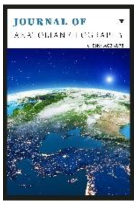

Analysis of Barriers to Sustainable Tourism Development with Interpretive Structural Modelling and Fuzzy PIPRECIA

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Abstract

This research aims to identify the barriers to sustainable tourism (ST) development, model the interrelationships between these barriers, and rank them in order of importance. The ST barriers were modelled and clustered using ISM (Interpretive Structural Modelling) and MICMAC (Matriced' Impacts Croise's Multiplication Applique'e a' un Classement), and their ordering was determined using the fuzzy PIPRECIA (PIvot Pairwise RElative Criteria Importance Assessment) technique. For this purpose, a new model integrating ISM, MICMAC, and fuzzy PIPRECIA methods was proposed for the first time in the literature to model and analyse the barriers to ST development. This proposed model was applied as a case study in Güzelyurt (Aksaray-Türkiye), an important tourism region of Cappadocia. According to the results, infrastructural and superstructure deficiencies, a focus on economic gain, a lack of cooperation and coordination among the stakeholders, the inability to provide economic benefits, the lack of a holistic planning approach, and a lack of sustainable tourism management practises were the most important barriers to sustainable tourism. It is thought that the findings and the proposed methodological framework will contribute to the ST research literature in a theoretical context. In practical terms, it is believed to indirectly contribute to possible ST planning and management in the Güzelyurt district.

Yorumlayıcı Yapısal Modelleme ve Bulanık PIPRECIA ile Sürdürülebilir Turizm Gelişimine Yönelik Engellerin Analizi

Anahtar Kelimeler
Sürdürülebilir turizm engelleri
ISM-MICMAC
Fuzzy PIPRECIA
Güzelyurt
Kapadokya

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Özet

Bu araştırmanın amacı sürdürülebilir turizm (ST) gelişiminin önündeki engelleri belirlemek, bu engeller arasındaki ilişkileri modellemek ve bunları önem sırasına göre sıralamaktır. ST engelleri YYM (Yorumlayıcı Yapısal Modelleme) ve MICMAC (Matriced' Impacts Croise's Multiplication Applique'e a' un Classement) kullanılarak modellenmiş ve kümelenmiş ve sıralamaları bulanık PIPRECIA (PIvot Pairwise Relative Criteria Importance Assessment) tekniği kullanılarak belirlenmiştir. Bu amaçla, ST gelişiminin önündeki engelleri modellemek ve analiz etmek için literatürde ilk kez YYM, MICMAC ve bulanık PIPRECIA yöntemlerini birleştiren yeni bir model önerilmiştir. Önerilen bu model, Kapadokya'nın önemli bir turizm bölgesi olan Güzelyurt'ta (Aksaray-Türkiye) bir vaka çalışması olarak uygulanmıştır. Sonuçlara göre, altyapı ve üstyapı eksiklikleri, ekonomik kazanıma odaklanma, paydaşlar arasında iş birliği ve koordinasyon eksikliği, ekonomik fayda sağlayamama, bütüncül bir planlama yaklaşımının eksikliği ve sürdürülebilir turizm yönetimi uygulamalarının eksikliği sürdürülebilir turizmin önündeki en önemli engellerdir. Bulguların ve önerilen metodolojik çerçevenin ST araştırma literatürüne teorik bağlamda katkı sağlayacağı düşünülmektedir. Pratik açıdan ise Güzelyurt ilçesinde olası ST planlama ve yönetimine dolaylı olarak katkı sağlayacağı düşünülmektedir.

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1. Introduction

Tourism has economic, sociocultural, and environmental consequences (Timur & Getz, 2009). These results and effects can occur both positively and negatively. In parallel with negative results, sustainable tourism (ST) activities worldwide have gained importance. ST is a tourism approach that considers current and future economic, sociocultural, and environmental impacts and meets the needs of visitors, industry, the environment, and host communities (UNWTO, 2013). ST has three pillars: economic, ecological, and sociocultural. Financial sustainability and development, environmental sustainability focus on the development-resource relationship, and sociocultural sustainability focus on the development-society relationship (Timur & Getz, 2009).

ST is known as tourism based on sustainable development concepts, taking complete account of economic, social, and environmental impacts (Tseng et al., 2018). To ensure sustainability, it is stated that there is a need to develop and manage tourism activities in destinations without compromising natural and cultural resources (Blancas et al., 2015). In particular, it is important to understand how various human activities interact with regional topographic conditions and the consequences of this interaction on biodiversity and ecosystem sustainability (Eraslan, 2024a). In this context, urban area development is seen as an important factor threatening the natural environment (Eraslan, 2024b). However, as in other sectors, it is known that there are various difficulties in ensuring sustainability in the tourism industry (Streimikiene et al., 2021). The intensity of these challenges tends to vary from place to place, and they are more prevalent in economies dependent on tourism activities (Dembovska & Zvaigzne, 2021).

It is stated that the implementation of ST is complicated due to the current socio-economic and political conditions, especially in developing countries (Tosun, 2001). Implementation of ST in these countries faces numerous challenges, including a lack of funding, qualified personnel, local community participation, and so on (Yadav & Sahu, 2015). Other pressing challenges in implementing ST include high energy consumption, food waste, general waste management, limited access to finance, and low investment levels (Pan et al., 2018).

When ST is considered in Türkiye, it is known that most of the problems and difficulties mentioned in the literature are also experienced in Türkiye. In his study, Tosun (2001) talked about the problems with ST in Turkey. These include the priorities of the national economy, the lack of a modern approach to tourism development, the structure of the public administration system, environmental problems, too much commercialisation, and the structure of the international tourism system, among other things.

Although there are many meaningful academic and practical discussions on ST in the literature, it is stated that decision-making in applying ST is complex (Mihalic, 2016). Management stakeholders, in particular, are perplexed about balancing and achieving tourism development's environmental, economic, and social goals (Zhang, 2016). In general, the barriers to ST have been addressed through conceptual studies. Apart from this, there are studies (García-Melón et al., 2012; Zhang, 2016; Hatipoğlu et al., 2016; Lee & Hsieh, 2016; Yadav et al., 2018; Tseng et al., 2018; Ocampo et al., 2018; Ren, 2020; Liu & Suk, 2021; Salamzadeh et al., 2021; Huang et al., 2022; Tajer & Demir, 2022; Tajer & Demir, 2024) evaluating ST and ST barriers empirically in the literature. However, few studies (Hatipoğlu et al., 2016; Yadav et al., 2018; Ren, 2020) empirically evaluate the mutual causal relationships between the barriers encountered in ST and the significance of the challenges. Based on this gap, the current study proposes a two-stage methodology consisting of ISM-MICMAC and fuzzy PIPRECIA, focusing on analysing barriers encountered in ST implementation.

One of these techniques, ISM, is proposed by Warfield (1974), in which direct and indirect relationships between different factors are defined together with their hierarchical structures. In this approach, the structure of a complex topic or problem is depicted in a carefully designed model that includes graphics and words (Shankar et al., 2003). Detailed information about the ISM methodology is presented in the method section. Many studies (Sindhu et al., 2016; Chen et al., 2021; Raut et al., 2018; Gholami et al., 2020; Trivedi et al., 2021) deal with the issue of sustainability barriers with the ISM technique. Some researchers define ISM in tourism as sustainable and rural tourism development (Yadav et al., 2018; Tseng et al., 2018; Weng et al., 2021; Zorlu et al., 2022; Hussain et al., 2024), customer satisfaction determination in spa tourism (Mi et al., 2019), medical tourism (Sadeh & Garkaz, 2019; Aiwerioghene et al., 2021), and analysis of factors affecting foreign investment (Gupta et al., 2021). For example, Yadav et al. (2018) analysed 16 ST barriers with ISM in their study in the Indian National Chambal Sanctuary (NCS) conservation area. According to their findings, they identified the lack of coordination among stakeholders and the lack of government incentives as the two most important ST barriers in the region. Building on the literature discussed above, the ISM methodology has been used to model and understand these advantages and the complex relationships among various barriers in many studies. For this reason, it would be appropriate to use the ISM technique to analyse mutual causal relationships between ST barriers in the current study.

In the second analysis phase of this study (to determine the importance level of ST barriers), MCDM techniques were also used. MCDM is a collection of tools and methods to solve problems with multiple and often conflicting criteria (Sodenkamp et al., 2018). Because in the real environment, successful decision-making usually requires consideration of more than one factor (criteria) (Peng et al., 2020). There are many criterion weighting techniques in the MCDM family of methods that are frequently used by researchers. Among these techniques, the AHP technique is quite widely used. However, in cases where the number of criteria is high, the number of pairwise criteria comparisons increases in the AHP technique, creating a disadvantage. In SWARA, another method, criteria are first listed according to their importance level. Researchers (Stanujkic et al., 2017) developed the PIPRECIA technique to overcome the mentioned techniques' complexity. However, in the classical PIPRECIA, evaluating the barriers to ST is challenging due to the decision-maker's vague, inconsistent, and ambiguous information. Indeed, since the MCDM technique often fails to address the uncertainty in real-world situations, many researchers have suggested using Zadeh's (1965) fuzzy set (FS) theory with MCDM (Abdel-Basset et al., 2018). Therefore, using a PIPRECIA technique integrated with fuzzy numbers was deemed appropriate in this study.

The Güzelyurt district (Aksaray-Türkiye), an important destination of the Cappadocia Region, was chosen as the case to prove the applicability of the proposed method. The reasons for selecting the Güzelyurt district as the study area are discussed in detail in the following sections. Since the two-stage methodological framework proposed in the study, the study is anticipated to make a theoretical contribution to the literature. In addition, it is thought that the study's findings will provide practical contributions to providing information to tourism stakeholders.

2. Material and Methods

2.1. Güzelyurt district and ST barriers

Güzelyurt district of Aksaray province is located in the south of the Central Kızılırmak Section of the Central Anatolia Region. The research area has a topography developed by volcanic-climatic-fluvial processes, and in this case, it is reflected in natural tourist attractions. In addition, the site, which has been a settlement since prehistoric times (Pekak, 1993), has significant historical and cultural touristic offerings. Despite the touristic attractions of the district (Ihlara and Manastırlar Valley, rock-carved churches, caves, fairy chimneys, tuff cones, Melendiz Stream, traditional architectural structures, folk culture elements, etc.), (Figure 1) the tourism activities carried out in the district have remained in the shadow of the Nevşehir region.

The district mainly provides services for the daily use of the Nevşehir region. As a result of the newly developing tourism activities in the district centre and the settlements around the Ihlara Valley, the number of tourists visiting the Güzelyurt district in 2019 was 17,642, while a total of 543,125 people visited the district's Ihlara Valley (Guzelyurt District Governorship, 2020). ST is still a distant concept for the district, which hosts many visitors yearly (Varnacı Uzun, 2012). Progress can only be made in the community with ST planning. As a result, it is critical to comprehend the barriers that stand in the way of ST in Güzelyurt, as well as the relationships between these barriers. For this reason, the present study aims to evaluate the challenges in front of ST in the district. For this purpose, 12 barriers (Table 1) were identified through an extensive literature review, expert opinions, and field studies.

With the methodological approach of the current study (explained in detail in the following sections), the causal relationships between these 12 barriers were examined, and inferences were made by finding the weights of the barriers.

2.2. Interpretive structural modeling (ISM)

First developed by Warfield, ISM is a methodological approach that belongs to the family of soft operations research approaches (Dev & Shankar, 2016). In the current study, the ISM methodology was chosen because of its advantages and because it has been used in many studies to model and understand the complex relationships between various barriers. The steps to implement the ISM methodology are as follows:

Step 1: The variable related to the subject (ST barriers in the current research) is determined.

Step 2: Contextual relationships are established between the determined variables.

Step 3: A structural self-interacting matrix (SSIM) is created, showing the binary relationships between the variables. The following four symbols represent the relationships between the variables *i* and *j*.

- V: The barrier *i* affects *j*, and *j* does not affect *i*.
- A: The *j* barrier affects *i*, and *i* do not affect *j*.
- X: The barrier *i* affects *j*, and *j* affects *i*.
- O: *i* and *j* have no connection.

Step 4: The initial accessibility matrix is obtained by replacing the letters (V, A, X, O) in the matrix obtained in the previous step with 1 and 0. The basic rules for 1 and 0 are as follows:

- If the relationship between *i* and *j* in SSIM is V, then entry *(i, j)* in the accessibility matrix is 1 and entry *(j, i)* is 0.
- If the relationship between *i* and *j* in SSIM is A, then entry *(i, j)* in the accessibility matrix is 0 and entry *(j, i)* is 1.
- If the relationship between *i* and *j* in SSIM is X, then the entry *(i, j)* and *(j, i)* in the accessibility matrix is 1.
- If the relationship between *i* and *j* in SSIM is 0, then the entry *(i, j)* and *(j, i)* in the accessibility matrix is 0.

The initial matrix is checked for transitivity to arrive at the final accessibility matrix. Transitivity rule; If the X barrier is related to the Y barrier and the Y barrier is associated with Z, then naturally, the X and Z barriers are also described.

Step 5: In this step, the final accessibility matrix obtained in the previous step is divided into different levels. The final accessibility matrix is converted to the conical matrix according to the accepted levels.

Step 6: A directional diagram consisting of nodes and arrows is drawn based on the data in the conic matrices.

Step 7: The transitive links in the diagram obtained in the previous step are removed, replaced with expressions at the nodes, and an ISM-based model is obtained.

Step 8: In the last step, MICMAC analysis is performed. developed by Warfield, ISM is a methodological

2.3. Operations on fuzzy numbers

If the membership function $\mu_{\tilde{A}}(x): R \rightarrow [0,1]$ is equal to Equation (1), a fuzzy number $\tilde{A}$ on R will be a triangular fuzzy number (TFN):

$$\mu_{\tilde{A}}(x) \begin{cases} \frac{x-l}{m-l} & l \leq x \leq m \\ \frac{u-x}{u-m} & m \leq x \leq u \\ 0 & otherwise \end{cases} \quad (1)$$

where *l* represents the lower and *u* upper bounds of the fuzzy number $\tilde{A}$ and *m* is the modal value. TFN can be marked as $\tilde{A} = (l, m, u)$.

The operations of TFN $\tilde{A}_1 = (l_1, m_1, u_1)$ and $\tilde{A}_2 = (l_2, m_2, u_2)$ are as follows:

(1) Addition:

$$\tilde{A}_1 \oplus \tilde{A}_2 = (l_1, m_1, u_1) + (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \quad (2)$$

(2) Multiplication:

$$\tilde{A}_1 \otimes \tilde{A}_2 = (l_1, m_1, u_1) \otimes (l_2, m_2, u_2) = (l_1 \times l_2, m_1 \times m_2, u_1 \times u_2) \quad (3)$$

Figure 1. Some of the important tourist attractions in Güzelyurt. a) Selime fairy chimneys, rock-carved structures and Selime Cathedral; b) and c) Ihlara Canyon; d) "Great Church Mosque" and examples of civil architecture in Güzelyurt Monastery Valley; e) Selime fairy chimneys; f) Melendiz River flowing through Ihlara Canyon.

Table 1. ST barriers.

ST Barriers	Hussain et al. (2024)	Connell et al. (2009)	Torres Delgado et al. (2021)	Dodds & Butler (2010)	Dodds (2007)	Hatipoğlu et al. (2016)	Harrison et al. (2003)	Neto (2003)	Pan et al. (2018)	Pektaş et al. (2014)	Timur & Getz (2009)	Tosun (2000)	Vamacı Uzun & Somuncu (2011, 2012)	Zorlu (2019, 2020)
B1- Lack of cooperation and coordination among stakeholders				✓	✓	✓	✓		✓		✓			✓
B2- Infrastructure and superstructure inadequacies		✓		✓						✓				✓
B3- Lack of knowledge and information	✓			✓	✓	✓			✓	✓	✓	✓	✓	
B4- Lack of interest and awareness	✓		✓	✓	✓	✓				✓	✓			✓
B5- Inability to generate economic income from tourism								✓					✓	✓
B6- Lack of a holistic planning approach				✓		✓	✓				✓			
B7- Prioritizing economic gain			✓	✓								✓	✓	✓
B8- The dominance of mass tourism								✓				✓		✓
B9- Lack of community participation	✓			✓	✓	✓		✓				✓	✓	
B10- Lack of local-scale tourism data	✓		✓			✓			✓					✓
B11- The pressure of tourism activities on the natural, historical and cultural environment								✓	✓	✓		✓		✓
B12- Lack of sustainable tourism management practices		✓		✓							✓	✓	✓	✓

(3) Subtraction:

$$\tilde{A}_1 \ominus \tilde{A}_2 = (l_1, m_1, u_1) - (l_2, m_2, u_2) = (l_1 - u_2, m_1 - m_2, u_2 - l_2) \quad (4)$$

(4) Division:

$$\frac{\tilde{A}_1}{\tilde{A}_2} = \frac{(l_1, m_1, u_1)}{(l_2, m_2, u_2)} = \left(\frac{l_1}{u_2}, \frac{m_1}{m_2}, \frac{u_1}{l_2}\right) \quad (5)$$

(5) Reciprocal:

$$\tilde{A}_1^{-1} = (l_1, m_1, u_1)^{-1} = \left(\frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1}\right) \quad (6)$$

2.4. Fuzzy PIPRECIA method

Sola The PIPRECIA method (Stanujkic et al., 2017) is known as a new MCDM approach used to determine the weight values of the criteria. Compared to SWARA, a similar method, the PIPRECIA method allows the evaluation of criteria without ranking them in order of importance (Stević et al., 2018; Đalić et al., 2020). The extension of the PIPRECIA method in fuzzy form was developed by Stević et al. (2018). The advantages of the PIPRECIA method emerge, especially with the group decision-making processes in fuzzy models (Stević et al., 2018). Many researchers (Stević et al., 2018; Stanković et al., 2020; Tomašević et al., 2020; Đalić et al., 2020; Vesković et al., 2020; Blagojević et al., 2020; Özdağoğlu et al., 2021; Arman & Kundakçı, 2022) have successfully applied the method in different subject areas. The fuzzy PIPRECIA method consists of 10 steps shown below (Stević et al., 2018; Tomašević et al., 2020; Vesković et al., 2020; Arman & Kundakçı, 2022;):

Step 1. A set of criteria is created to be evaluated by experts. In this step, all criteria from the first to the last criterion are listed without being classified.

Step 2. To determine the relative importance of the criteria, each decision maker evaluates the previously listed criteria separately, starting from the second criterion, as in Equation (7).

$$\overline{s_j^r} = \begin{cases} > \bar{1} \; if \; C_j > C_j - 1 \\ = \bar{1} \; if \; C_j = C_j - 1 \\ < \bar{1} \; if \; C_j < C_j - 1 \end{cases} \quad (7)$$

where $\overline{s_j^r}$ denotes the evaluation of the criteria by the decision maker r. Then, to obtain a linguistic matrix $\overline{s_j}$, it is necessary to take the average of the matrix $\overline{s_j^r}$ using the geometric mean. Decision makers evaluate the criteria by applying the scales in Tables 2 and 3.

Table 2. Scale 1–2 for evaluation of criteria.

Linguistic term			TFNs			
			l	*m*	*u*	DFV
Almost equal value	Scale 1-2	1	1.000	1.000	1.050	1.008
Slightly more significant		2	1.100	1.150	1.200	1.150
Moderately more significant		3	1.200	1.300	1.350	1.292
More significant		4	1.300	1.450	1.500	1.433
Much more significant		5	1.400	1.600	1.650	1.575
Dominantly more significant		6	1.500	1.750	1.800	1.717
Absolutely more significant		7	1.600	1.900	1.950	1.858

Table 3. Scale 0-1 for evaluation of criteria.

TFNs						Linguistic term
l	*m*	*u*	DFV			
0.667	1.000	1.000	0.944	1*	Scale 0-1	Weakly less significant
0.500	0.667	1.000	0.694	2*		Moderately less significant
0.400	0.500	0.667	0.511	3*		Less significant
0.333	0.400	0.500	0.406	4*		Really less significant
0.286	0.333	0.400	0.337	5*		Much less significant
0.250	0.286	0.333	0.288	6*		Dominantly less significant
0.222	0.250	0.286	0.251	7*		Absolutely less significant

Step 3. The coefficient $\overline{k_j}$ is determined as in Equation (8).

$$\overline{k_j} = \begin{cases} = 1 \; if \; j = 1 \\ 2 - \overline{s_j} \; if \; j = 1 \end{cases} \tag{8}$$

Step 4. Fuzzy weight values $(\overline{q_j})$ are determined.

$$\overline{q_j} = \begin{cases} = \bar{1} \; if \; j = 1 \\ \dfrac{\overline{q_j - 1}}{\overline{k_j}} \; if \; j > 1 \end{cases} \tag{9}$$

Step 5. The relative weight of criteria $\overline{w_j}$ is determined.

$$\overline{w_j} = \frac{\overline{q_j}}{\sum_{j=1}^{n} \overline{q_j}} \tag{10}$$

The next steps include the application steps of the inverse fuzzy PIPRECIA method.

Step 6. Starting from the penultimate criterion, inter-criteria evaluation is made according to Table 2 and Table 3.

$$\overline{s_j^{r\prime}} = \begin{cases} > \bar{1} \; if \; C_j > C_j + 1 \\ = \bar{1} \; if \; C_j = C_j + 1 \\ < \bar{1} \; if \; C_j < C_j + 1 \end{cases} \tag{11}$$

Step 7. $\bar{k}_j'$ coefficient is determined as in Equation (12).

$$\bar{k}_j' = \begin{cases} = 1 \; if \; j = n \\ 2 - \bar{s}_j' \; if \; j = n \end{cases} \tag{12}$$

where, *n* indicates the total number of criteria.

Step 8. Fuzzy weight values $(\bar{q}_j')$ are determined.

$$\bar{q}_j' = \begin{cases} = \bar{1} \; if \; j = n \\ \dfrac{\overline{q_{J-1'}}}{\overline{k_{J'}}} \; if \; j > n \end{cases} \tag{13}$$

Step 9. The relative weight of criteria $\bar{w}_j'$ is determined.

$$\bar{w}_j' = \frac{\bar{q}_j'}{\sum_{j=1}^{n} \bar{q}_j'} \tag{14}$$

Step 10. The average value of $\bar{w}_j''$ needs to be calculated to determine the final weights of the criteria.

$$\bar{w}_j'' = \frac{\bar{w}_j + \bar{w}_j'}{2} \tag{15}$$

3. Results

3.1. ISM analysis

In implementing the ISM, expert opinions are considered to determine the relationships between the identified barriers. A group of seven experts was selected for the study (Table 4).

Table 4. Details of the decision panel.

Experts	Organisation	Education	Experience (year)
E1	University-Academia	Ph.D.	10
E2	University-Academia	Ph.D.	15
E3	Tourism company	Master	9
E4	University-Academia	Ph.D.	12
E5	University-Academia	Ph.D.	17
E6	University-Academia	Master	3
E7	Tourism company	Master	13

By following the application steps of the ISM methodology (1-4 steps), the experts evaluated the relationships between the 12 variables that prevent ST. As a result of this process, a structural self-interacting matrix (SSIM) (Table 5), an initial reachability matrix (Table 6), and a final reachability matrix (Table 7) were obtained.

Table 5. Development of a structural self-interacting matrix (SSIM).

Barriers	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	X	O	V	O	O	V	O	O	X	V	O	A
B2		X	O	O	A	O	O	O	O	O	V	O
B3			X	O	O	A	O	V	O	V	O	O
B4				X	A	O	O	O	A	V	O	O
B5					X	X	V	O	A	O	O	A
B6						X	O	V	X	O	V	V
B7							X	X	O	O	V	O
B8								X	O	O	V	A
B9									X	V	O	A
B10										O	X	A
B11											X	A
B12												X

Not(s): B-Barriers; B1- Lack of cooperation and coordination among stakeholders; B2- Infrastructure and superstructure inadequacies; B3- Lack of knowledge and information; B4- Lack of interest and awareness; B5- Inability to generate economic income from tourism; B6- Lack of a holistic planning approach; B7- Prioritizing economic gain; B8- The dominance of mass tourism; B9- Lack of community participation; B10- Lack of local-scale tourism data; B11- The pressure of tourism activities on the natural, historical and cultural environment; B12- Lack of sustainable tourism management practices.

Table 6. Initial reachability matrix.

Barriers	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1	1	0	1	0	0	1	0	0	1	1	0	0
B2	0	1	0	0	0	0	0	0	0	0	1	0
B3	0	0	1	0	0	0	0	0	0	1	0	0
B4	0	0	0	1	0	0	0	0	0	0	0	0
B5	0	1	0	1	1	1	1	0	0	0	0	0
B6	0	0	1	0	1	1	0	1	1	0	1	1
B7	0	0	0	0	0	0	1	1	0	0	1	0
B8	0	0	0	0	0	0	1	1	0	1	1	0
B9	1	0	0	1	1	1	0	0	1	0	0	0
B10	0	0	0	0	0	0	0	0	0	1	1	0
B11	0	0	0	0	0	0	0	0	0	1	1	0
B12	1	0	0	0	1	0	0	1	1	1	1	1

Table 7. Final reachability matrix.

Barriers	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	Driving power
B1	1	1*	1	1*	1*	1	1*	1*	1	1	1*	1*	12
B2	0	1	0	0	0	0	0	0	0	1*	1	0	3
B3	0	0	1	0	0	0	0	0	0	1	1*	0	3
B4	0	0	0	1	0	0	0	0	0	0	0	0	1
B5	1*	1	1*	1	1	1	1	1*	1*	1*	1*	1*	12
B6	1*	1*	1	1*	1	1	1*	1	1	1*	1	1	12
B7	0	0	0	0	0	0	1	1	0	1*	1	0	4
B8	0	0	0	0	0	0	1	1	0	1	1	0	4
B9	1	1*	1*	1	1	1	1*	1*	1	1*	1*	1*	12
B10	0	0	0	0	0	0	0	0	0	1	1	0	2
B11	0	0	0	0	0	0	0	0	0	1	1	0	2
B12	1	1*	1*	1*	1	1*	1*	1	1	1	1	1	12

Dependence Power	5	6	6	6	5	5	7	7	5	11	11	5

* Transitivity means the value after consideration.

At this stage (Step 5), the levelling process (Table 8) was performed to determine the degree of importance of the barriers in front of the ST. Later, the conical matrix (Table 9) was developed.

Table 8. Level partitioning (Iteration I-II-III).

Barriers	Reachability Set R(Mi)	Antecedent Set A(Ni)	Intersection Set R(Mi) ∩ A(Ni)	Level
B1	1, 2, 3, 5, 6, 7, 8, 9, 12,	1, 5, 6, 9, 12,	1, 5, 6, 9, 12,	III
B2	2,	1, 2, 5, 6, 9, 12,	2,	II
B3	3,	1, 3, 5, 6, 9, 12,	3,	II
B4		1, 5, 6, 9, 12,		I
B5	1, 2, 3, 5, 6, 7, 8, 9, 12,	1, 5, 6, 9, 12,	1, 5, 6, 9, 12,	III
B6	1, 2, 3, 5, 6, 7, 8, 9, 12,	1, 5, 6, 9, 12,	1, 5, 6, 9, 12,	III
B7	7, 8,	1, 5, 6, 7, 8, 9, 12,	7, 8,	II
B8	7, 8,	1, 5, 6, 7, 8, 9, 12,	7, 8,	II
B9	1, 2, 3, 5, 6, 7, 8, 9, 12,	1, 5, 6, 9, 12,	1, 5, 6, 9, 12,	III
B10		1, 2, 3, 5, 6, 7, 8, 9, 12,		I
B11		1, 2, 3, 5, 6, 7, 8, 9, 12,		I
B12	1, 2, 3, 5, 6, 7, 8, 9, 12,	1, 5, 6, 9, 12,	1, 5, 6, 9, 12,	III

Table 9. Reduced conical matrix.

Barriers	B4	B10	B11	B2	B3	B7	B8	B1	B5	B6	B9	B12	Driving power	Level
B4	1	0	0	0	0	0	0	0	0	0	0	0	1	I
B10	0	1	1	0	0	0	0	0	0	0	0	0	2	I
B11	0	1	1	0	0	0	0	0	0	0	0	0	2	I
B2	0	1*	1	1	0	0	0	0	0	0	0	0	3	II
B3	0	1	1*	0	1	0	0	0	0	0	0	0	3	II
B7	0	1*	1	0	0	1	1	0	0	0	0	0	4	II
B8	0	1	1	0	0	1	1	0	0	0	0	0	4	II
B1	1*	0	0	1*	1	1*	1*	1	1*	1	1	1*	12	III
B5	1	0	0	1	1*	1	1*	1*	1	1	1*	1*	12	III
B6	1*	0	0	1*	1	1*	1	1*	1	1	1	1	12	III
B9	1	0	0	1*	1*	1*	1*	1	1	1	1	1*	12	III
B12	1*	0	0	1*	1*	1*	1	1	1	1*	1	1	12	III
Dependence Power	6	11	11	6	6	7	7	5	5	5	5	5		

The first diagram showing the interrelationships between the barriers was obtained using the conic matrix obtained in the previous step. Then, by removing transitivity from the diagram and replacing the nodes with expressions, the final structural-interpretive model was obtained (Figure 2). Any arrow from barrier *i* to barrier *j* indicates that barrier *i* can result in barrier *j*, while a two-way arrow indicates a reciprocal relationship between barriers.

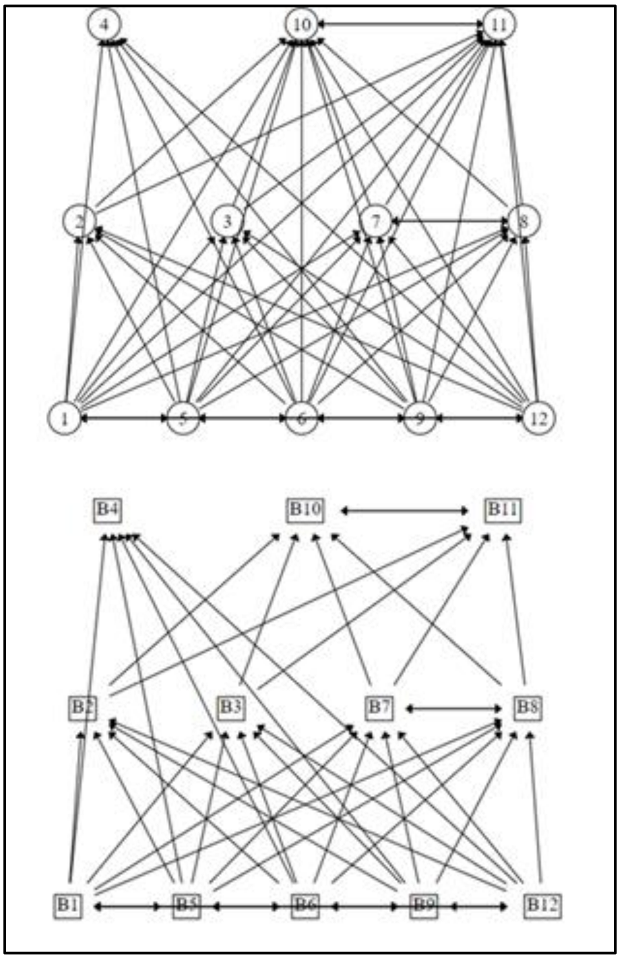

Figure 2. Interpretive structural model of ST barriers. *Not(s): B- Barriers; B1- Lack of cooperation and coordination among stakeholders; B2- Infrastructure and superstructure inadequacies; B3- Lack of knowledge and information; B4- Lack of interest and awareness; B5- Inability to generate economic income from tourism; B6- Lack of a holistic planning approach; B7- Prioritizing economic gain; B8- The dominance of mass tourism; B9- Lack of community participation; B10- Lack of local-scale tourism data; B11- The pressure of tourism activities on the natural, historical and cultural environment; B12- Lack of sustainable tourism management practices.*

3.2. MICMAC analysis

The final stage of ISM is MICMAC (Matriced' Impacts Croise's Multiplication Applique'e a' un Classement) analysis. MICMAC analysis categorises all barriers into four categories: (I) autonomous, (II) dependent, (III) linked, and (IV) independent, based on their driving and dependent forces. MICMAC analysis findings are presented in Figure 3.

Autonomous barriers (I): These represent barriers that have weak driving and dependency powers and are relatively disconnected from the system. There are no barriers in this cluster in the analysis. However, B2, B3, and B4 are on the border of autonomous and dependent barriers. Dependent barriers (II): It has a weak repulsive and strong dependent power, so barriers in this group are affected by independent or connection barriers. The present study identified B7, B8, B10, and B11 as dependent barriers. These barriers are highly dependent on the barriers in the independent group (B1, B5, B6, B9, and B12). Linkage barriers (III) consist of high driving and dependent barriers. In the current research, no connection barriers were detected. Independent barriers

(IV) have a high driving force but a low dependent power. These are the main barriers; any change will also affect the other barriers. The research findings included B1, B5, B6, B9, and B12 in this disability class.

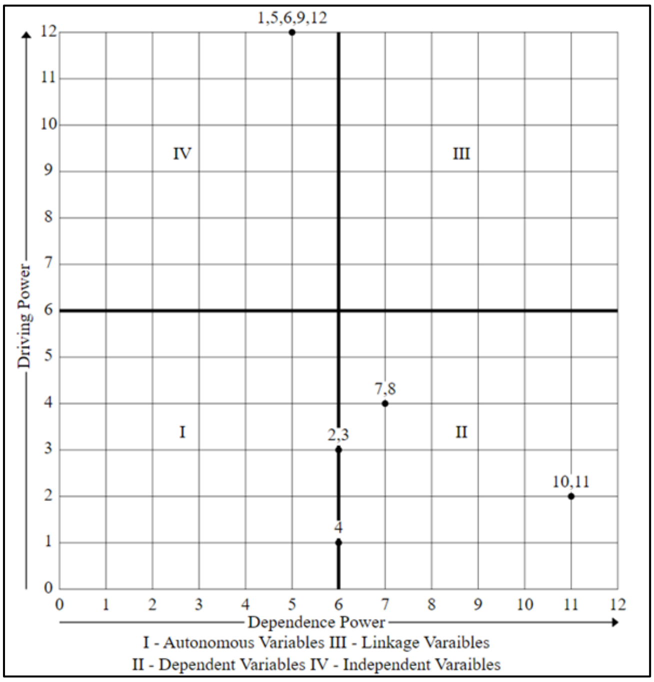

Figure 3. MICMAC analysis.

3.3. Weighting of criteria with fuzzy PIPRECIA

The first stage of the analysis involves applying the steps of fuzzy PIPRECIA and Inverse fuzzy PIPRECIA. Tables 10 and 11 show the evaluations of three different DMs (DMs consist of academics related to the field of tourism) and a geometric mean (GM) of those opinions.

Table 10. DMs' opinions on the criteria (Fuzzy PIPRECIA).

PIPRECIA	B1			B2			B3			B4		
DM1				1,600	1,900	1,950	0,250	0,286	0,333	1,300	1,450	1,500
DM2				1,500	1,750	1,800	0,333	0,400	0,500	1,200	1,300	1,350
DM3				1,500	1,750	1,800	0,333	0,400	0,500	1,100	1,150	1,200
GM				1,533	1,799	1,849	0,303	0,358	0,437	1,197	1,294	1,344
	B5			B6			B7			B8		
DM1	1,500	1,750	1,800	0,667	1,000	1,000	1,100	1,150	1,200	0,286	0,333	0,400
DM2	1,400	1,600	1,650	1,100	1,150	1,200	1,200	1,300	1,350	0,400	0,500	0,667
DM3	1,600	1,900	1,950	1,200	1,300	1,350	1,400	1,600	1,650	0,250	0,286	0,333
GM	1,498	1,746	1,796	0,958	1,143	1,174	1,227	1,337	1,388	0,306	0,362	0,446
	B9			B10			B11			B12		
DM1	1,200	1,300	1,350	0,333	0,400	0,500	1,200	1,300	1,350	1,500	1,750	1,800
DM2	1,100	1,150	1,200	1,100	1,150	1,200	1,300	1,450	1,500	1,500	1,750	1,800
DM3	1,100	1,150	1,200	0,250	0,286	0,333	1,200	1,300	1,350	1,600	1,900	1,950
GM	1,132	1,198	1,248	0,451	0,509	0,585	1,232	1,348	1,398	1,533	1,799	1,849

Table 11. DMs' opinions on the criteria (inverse fuzzy PIPRECIA).

I-PIPRECIA	B12			B11			B10			B9		
DM1				0,400	0,500	0,667	0,286	0,333	0,400	1,300	1,450	1,500
DM2				0,667	1,000	1,000	0,400	0,500	0,667	1,200	1,300	1,350
DM3				0,667	1,000	1,000	0,333	0,400	0,500	1,100	1,150	1,200
GM				0,562	0,794	0,874	0,336	0,405	0,511	1,197	1,294	1,344
	B8			B7			B6			B5		
DM1	0,400	0,500	0,667	1,400	1,600	1,650	1,400	1,600	1,650	1,300	1,450	1,500
DM2	0,286	0,333	0,400	1,500	1,750	1,800	1,400	1,600	1,650	1,400	1,600	1,650
DM3	0,286	0,333	0,400	1,500	1,750	1,800	1,500	1,700	1,800	1,600	1,900	1,950
GM	0,320	0,381	0,474	1,466	1,698	1,749	1,433	1,649	1,699	1,428	1,640	1,690
	B4			B3			B2			B1		
DM1	1,100	1,150	1,200	1,100	1,150	1,200	1,400	1,600	1,650	0,286	0,333	0,400
DM2	0,500	0,667	1,000	0,500	0,667	1,000	1,500	1,750	1,800	0,400	0,500	0,667
DM3	0,333	0,400	0,500	1,000	1,000	1,050	1,600	1,900	1,950	0,333	0,400	0,500
GM	0,568	0,674	0,843	0,819	0,915	1,080	1,498	1,746	1,796	0,336	0,405	0,511

In the second step, based on Equation (7), a $\overline{s_j}$ matrix was created as follows (Table 12):

$$\overline{s_2} = (1.533, 1.799, 1.849)$$
$$\overline{s_3} = (0.612, 0.756, 0.814)$$
$$\overline{s_4} = (1.266, 1.398, 1.448)$$
… … …
$$\overline{s_{12}} = (1.533, 1.799, 1.849)$$

Then, by applying Equation (8), the values in the $\overline{s_j}$ matrix were subtracted from two numbers to obtain the $\overline{k_j}$ matrix.

According to Equation (8), the value $\overline{k_1}$= (1.000, 1.000, 1.000)

$$\overline{k_2} = (2 - 1.849, 2 - 1.799, 2 - 1.533) = (0.151, 0.201, 0.467)$$
$$\overline{k_3} = (2 - 0.437, 2 - 0.358, 2 - 0.303) = (1.563, 1.642, 1.697)$$
$$\overline{k_4} = (2 - 1.344, 2 - 1.294, 2 - 1.197) = (0.656, 0.706, 0.803)$$
… … …
$$\overline{k_{12}} = (2 - 1.849, 2 - 1.799, 2 - 1.533) = (0.151, 0.201, 0.467)$$

According to Equation (9), $\overline{q_j}$ values were obtained as follows:

$\overline{q_1}$= (1.000, 1.000, 1.000)

$$\overline{q_2} = \left(\frac{1.000}{0.467}, \frac{1.000}{0.201}, \frac{1.000}{0.151}\right) = (2.140, 4.966, 6.608)$$
$$\overline{q_3} = \left(\frac{2.140}{1.697}, \frac{4.966}{1.642}, \frac{6.608}{1.563}\right) = (1.261, 3.024, 4.227)$$
$$\overline{q_4} = \left(\frac{1.261}{0.803}, \frac{3.024}{0.706}, \frac{4.227}{0.656}\right) = (1.570, 4.284, 6.448)$$
… … …
$$\overline{q_{12}} = \left(\frac{2.222}{0.467}, \frac{23.250}{0.201}, \frac{6.448}{0.151}\right) = (4.754, 115.462, 414.942)$$

Applying equation (10), the relative weights were calculated as follows:

$$\overline{w_1} = \left(\frac{1.000}{29.600}, \frac{1.000}{274.069}, \frac{1.000}{759.812}\right) = (0.034, 0.004, 0.001)$$
$$\overline{w_2} = \left(\frac{2.140}{29.600}, \frac{4.966}{274.069}, \frac{6.608}{759.812}\right) = (0.072, 0.018, 0.009)$$
$$\overline{w_3} = \left(\frac{1.261}{29.600}, \frac{3.024}{274.069}, \frac{4.227}{759.812}\right) = (0.043, 0.011, 0.006)$$
… … …

$$\overline{w_{12}} = \left(\frac{4.754}{29.600}, \frac{115.462}{274.069}, \frac{414.942}{759.812}\right) = (0.161, 0.421, 0.546)$$

Table 12. Calculation and results of fuzzy PIPRECIA for criteria.

PIPRECIA	s_j			k_j			q_j			w_j			DF
B1				1,000	1,000	1,000	1,000	1,0000	1,0000	0,034	0,004	0,001	0,008
B2	1,533	1,799	1,849	0,151	0,201	0,467	2,140	4,966	6,608	0,072	0,018	0,009	0,026
B3	0,303	0,358	0,437	1,563	1,642	1,697	1,261	3,024	4,227	0,043	0,011	0,006	0,015
B4	1,197	1,294	1,344	0,656	0,706	0,803	1,570	4,284	6,448	0,053	0,016	0,008	0,021
B5	1,498	1,746	1,796	0,204	0,254	0,502	3,127	16,848	31,579	0,106	0,061	0,042	0,066
B6	0,958	1,143	1,174	0,826	0,857	1,042	3,002	19,669	38,252	0,101	0,072	0,050	0,073
B7	1,227	1,337	1,388	0,612	0,663	0,773	3,884	29,684	62,485	0,131	0,108	0,082	0,108
B8	0,306	0,362	0,446	1,554	1,638	1,694	2,293	18,127	40,215	0,077	0,066	0,053	0,066
B9	1,132	1,198	1,248	0,752	0,802	0,868	2,642	22,601	53,481	0,089	0,082	0,070	0,082
B10	0,451	0,509	0,585	1,415	1,491	1,549	1,706	15,154	37,785	0,058	0,055	0,050	0,055
B11	1,232	1,348	1,398	0,602	0,652	0,768	2,222	23,250	62,792	0,075	0,085	0,083	0,083
B12	1,533	1,799	1,849	0,151	0,201	0,467	4,754	115,462	414,942	0,161	0,421	0,546	0,399
							29,60	274,069	759,812				1,00

Equation (11)–(15), the inverse fuzzy PIPRECIA method methodology, must be applied to determine the final weights of the criteria. The only difference between these and the above steps is that they are calculated starting from the last criterion (Table 13).

Table 13. Calculation and results of fuzzy inverse PIPRECIA for criteria.

I-PIPRECIA	s_j			k_j			q_j			w_j			DF
B1	0,336	0,405	0,511	1,489	1,595	1,664	1,266	20,438	73,223	0,105	0,223	0,279	0,213
B2	1,498	1,746	1,796	0,204	0,254	0,502	2,106	32,591	109,033	0,175	0,356	0,416	0,336
B3	0,819	0,915	1,080	0,920	1,085	1,181	1,058	8,288	22,262	0,088	0,091	0,085	0,089
B4	0,568	0,674	0,843	1,157	1,326	1,432	1,249	8,989	20,479	0,104	0,098	0,078	0,096
B5	1,428	1,640	1,690	0,310	0,360	0,572	1,788	11,915	23,685	0,149	0,130	0,090	0,127
B6	1,433	1,649	1,699	0,301	0,351	0,567	1,023	4,294	7,344	0,085	0,047	0,028	0,050
B7	1,466	1,698	1,749	0,251	0,302	0,534	0,580	1,509	2,214	0,048	0,016	0,008	0,020
B8	0,320	0,381	0,474	1,526	1,619	1,680	0,310	0,455	0,557	0,026	0,005	0,002	0,008
B9	1,197	1,294	1,344	0,656	0,706	0,803	0,521	0,737	0,849	0,043	0,008	0,003	0,013
B10	0,336	0,405	0,511	1,489	1,595	1,664	0,418	0,520	0,557	0,035	0,006	0,002	0,010
B11	0,562	0,794	0,874	1,126	1,206	1,438	0,696	0,829	0,888	0,058	0,009	0,003	0,016
B12				1,000	1,000	1,000	1,000	1,000	1,000	0,083	0,011	0,004	0,022
							12,015	91,564	262,091				1,000

The final weights of the criteria are obtained by applying Equation (15). The final weights of the criteria are presented in Table 14.

$$\bar{w}_1'' = \frac{0.008 + 0.213}{2} = 0.111$$

$$\bar{w}_2'' = \frac{0.026 + 0.336}{2} = 0.181$$

$$\bar{w}_3'' = \frac{0.015 + 0.089}{2} = 0.052$$

… … …

$$\bar{w}_{12}'' = \frac{0.399 + 0.022}{2} = 0.210$$

Table 14. Final weights of criteria.

Barriers	**Weights**	**Rank**
B1- Lack of cooperation and coordination among stakeholders	0,111	3
B2- Infrastructure and superstructure inadequacies	0,181	2
B3- Lack of knowledge and information	0,052	8
B4- Lack of interest and awareness	0,058	7
B5- Inability to generate economic income from tourism	0,096	4
B6- Lack of a holistic planning approach	0,062	6
B7- Prioritizing economic gain	0,064	5
B8- The dominance of mass tourism	0,037	11
B9- Lack of community participation	0,047	10
B10- Lack of local-scale tourism data	0,032	12
B11- The pressure of tourism activities on the natural, historical and cultural environment	0,050	9
B12- Lack of sustainable tourism management practices	0,210	1

4. Discussion

4.1. General inference

In the present study, results based on two different methodologies were obtained. When the results of the ISM analysis are examined;

First, at the bottom of the hierarchy, B1 (lack of coordination among stakeholders), B5 (inability to generate economic income from tourism), B6 (lack of a holistic planning approach), B9 (lack of community participation), and B12 (lack of sustainable tourism management practises) are the most effective barriers to ST implementation. In MICMAC analysis, these are independent barriers with high driving power and weak, dependent power. These five barriers are seen as the main barriers and play a significant role in forming all other barriers. For this reason, since any change or improvement will affect other barriers, these barriers are significant in implementing ST in the Güzelyurt district. At the next level of the hierarchy, B2 (inadequacies in infrastructure and superstructure), B3 (lack of knowledge and information), B7 (prioritising economic gain), and B8 (the dominance of mass tourism) took place. B7 and B8 (with B10 and B11) of these barriers are weak driving, dependent barriers with strong addictive powers. It is also at the second level in B2 and B3, which are on the border of autonomous-dependent barriers. Since dependent barriers depend on other barriers, a possible improvement in other barriers will also improve dependent barriers. Autonomous barriers represent barriers disconnected from the system and should be addressed in depth in ST applications. At the top of the ISM hierarchy are B4 (lack of interest and awareness), B10 (lack of local-scale tourism data), and B11 (the pressure of tourism activities on the natural, historical, and cultural environment). Of these barriers, B4 is at the border of autonomous-dependent barriers, while B10 and B11 are included in the class of dependent barriers. Since these barriers are at the top of the hierarchy, they are seen as the least important ones.

Secondly, according to the fuzzy PIPRECIA findings, the barriers were identified in order from the most important to the least important; B12 → B2 → B1 → B5 → B7 → B6 → B4 → B3 → B11 → B9 → B8 → B10. The main barriers in the ISM findings are B5, B6, and B12, with high-importance values. B2 and B7 are intermediate-level barriers.

Different interpretations can be made by taking all the findings in the present study as a reference. Firstly, the lack of sustainable management practices has been identified as an essential factor preventing ST development in the district. The element in question can be considered a combination of all other factors (e.g., lack of community participation, lack of cooperation and coordination, focus on economic gain, and lack of a holistic planning understanding). Ballantyne et al. (2009) suggested that natural areas should be protected within the sustainability framework of good tourism management practices and that stakeholders should act together. Therefore, it is necessary to establish mechanisms linking the participation of stakeholders in the planning process to ST practices (Hatipoğlu et al., 2016).

Secondly, one of the district's most significant barriers to ST is the lack of infrastructure and superstructure investments. This finding is broadly consistent with similar studies' results (Hatipoğlu et al., 2016; Yadav et al., 2018; Graci & Vliet, 2020; Ren, 2020; Liu & Suk, 2021; Jena & Dwivedi, 2021). The most important reason is that public and private sector investments primarily focus on other regions of Cappadocia. Although the district is an important tourism region of Cappadocia, it has not been at the forefront like other regions (Ürgüp, Göreme, Avanos etc.). This has led to insufficient tourism investments in the district. Suppose the basic infrastructure and superstructure are inadequate. In that case, the community, which hosts more than five hundred thousand visitors annually (mostly excursionists), is more likely to feel the negative effects of tourism.

Thirdly, the lack of cooperation and coordination among the stakeholders and the lack of holistic planning understanding. As suggested in the literature (Yüksel et al., 2005; Lozano, 2008; Hatipoğlu et al., 2016; Tseng et al., 2018), cooperation and synchronised decision-making are essential for the sustainability of destinations. Indeed, Tseng et al. (2018) emphasised that cooperation between tourism parties is a critical issue in tapping into previously inaccessible markets and taking advantage of opportunities to improve ST. Hatipoglu et al. (2016), on the other hand, found in their study that a large number of parties should be involved in the development of projects, and it is recommended to establish institutional structures to facilitate cooperation between stakeholders with conflicting interests. However, they also stated that it is difficult to establish such a cooperation platform in Türkiye due to deficiencies in the legal framework. In addition, it was underlined that the lack of a holistic approach in the community might prevent sustainable tourism's realisation (Hatipoğlu et al., 2016).

Fourthly, there are the findings on economic sustainability, which is one of the three pillars of ST. Due to both analyses, the fact that the district residents could not benefit from tourism and, as a result, focused on economic gain was determined to be an essential finding. Tourism is often seen as important only for its economic benefits to relevant stakeholders (Tosun, 2001; Alipour & Kılıç, 2005; Blackstock, 2005; Bramwell & Lane, 2005; Dodds, 2007). In the general framework, Tosun (2001) stated that tourism development is mainly based on long-term investments but carried out for short-term benefits. He argued that this was due to the macroeconomic imperatives of developing countries. This determination, consistent with the literature's (Varnacı Uzun & Somuncu, 2012; Zhang, 2016; Hatipoğlu et al., 2016; Graci & Vliet, 2020) findings, shows that economic sustainability, one of the easiest three pillars of sustainability in the district, cannot be achieved. For this reason, the reflection of an understanding that focuses on the economic benefit of environmental resources will also be negative.

Fifthly, the lack of community participation in tourism throughout the district is an important ST problem. The community engagement paradigm is considered an integral component of ST (Cole, 2006; Waligo et al., 2013; Wang & Ap, 2013). As suggested in the literature (Cole, 2006; Moscardo, 2008; Aref, 2011; Graci & Vliet, 2020; Tosun, 2000), it has been determined that not including community members in tourism decision-making processes in the district is an important ST barrier. Cole (2006) stated that lack of knowledge, skills, trust, capital, and belief are the most important barriers to community participation. Graci and Vliet (2020) also emphasised the necessity of building community capacity for ST development. Involving all stakeholders in relevant decisions with a participatory approach in tourism facilitates the acceptance and implementation of strategic management plans. At the same time, it is considered necessary to create a sustainability strategy for the destination and to ensure collective decisions.

5. Conclusion

Using integrated ISM, MICMAC, and fuzzy PIPRECIA techniques, the current study attempted to explain the hierarchical structure of the barriers limiting ST in an essential region of Cappadocia. The results of the methods used are based entirely on mathematical models. ST barriers were classified into three hierarchies as a result of two-stage analyses. These three hierarchies of barriers provide a holistic scenario for understanding the importance of ST barriers in the county. In addition, based on the opinion of the group that has expertise in the field and the subject, the importance levels of ST barriers in the district were determined. The fuzzy PIPRECIA technique, which allows experts to define the weight value in determining the importance levels of the barriers, has produced more reliable and original results than the traditional PIPRECIA. All the findings will provide policymakers at the national and local levels with ideas to facilitate ST development in the district. However, while contributing to the theory, the integrated use of ISM and fuzzy PIPRECIA techniques in analysing barriers to ST development would make sense.

This study was conducted with some limitations. These limitations may need to be considered in future studies. First, the research analyses are based on expert opinions, which may vary according to different groups. In addition, although many criteria affect ST, some criteria specific to the research field have been selected. Secondly, a few respondents with knowledge and experience on the subject were chosen rather than a large number of experts. Finally, the lack of statistical validity of the results obtained in the ISM and fuzzy PIPRECIA approaches is one of the study's limitations.

Contribution rate of researchers

Kuttusi Zorlu: Literature review, Field study, Modeling, Article writing; **Volkan Dede**: Editing, Analysis, Article writing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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