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Determining strategies for the cadastre 2034 vision using an AHP-Based SWOT analysis: A case study for the turkish cadastral and land administration system

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ABSTRACT

This study aimed to identify the current land management and cadastre system in Turkey and determine the most appropriate strategy for integrating the current structure with the principles of the Cadastre 2034 vision. In this work, the legal, institutional, and technical (LIT) status of the existing land management and cadastre system in Turkey was determined using a method based on **S**trengths, **W**eaknesses, **O**pportunities, and **T**hreats (SWOT) and Analytic Hierarchy Process (AHP). Initially, the advantages or weaknesses of the existing land management and cadastre system in Turkey in terms of LIT aspects, opportunities, and threats arising from the external environment were determined by the SWOT matrix. Then, the information obtained concerning the existing land management and cadastre system in Turkey using this matrix was integrated into AHP and the most appropriate strategy was determined in terms of LIT aspects. For the existing land management and cadastre system in Turkey, from the legal point of view, the best strategy with a weighting of 30% was to 'update the land administration legislation according to the conditions of the day'. The best strategy in terms of institutionalization was to 'disseminate in-vocational training for the training of qualified personnel (28% weighting)' and the best strategy from the technical perspective was identified as, 'the use of technical and technologically advanced measurement techniques in spatial data collection (38% weighting)'. The goal in implementing the AHP-Based SWOT method is to improve the quantitative information basis of strategic planning processes. So, SWOT provides the basic outline within which to perform an analysis of the decision situation, and the AHP assists in carrying out SWOT more analytically and in elaborating the analysis so that alternative strategic decisions can be prioritised.

1. Introduction

The cadastral systems of the future can only contribute to the expansion of the scope of ownership by being a system that guarantees this ownership (Steudler et al., 2004). A further contribution is the transformation of current cadastral systems into land information systems and the achievement of sustainable development (Williamson, 2001). In this context, the Cadastre 2014 vision was developed, which aimed to encourage the implementation of LIT team arrangements in cadastral systems, and this vision has been accepted by many countries. Cadastre 2014 includes information and suggestions on the future status of the cadastral systems in the world, current reform projects, and trends related to the cadastre, the role of the cadastre in Cadastre 2014, and what needs to be done to make this role more effective (Cete, 2008). The institution responsible for land administration and cadastre activities in Turkey is the General Directorate of Land Registry and Cadastre (GDLRC), which aims to maintain the services provided at the institutional level in accordance with the understanding of modern land administration realized at the international level. Closely following international developments within the scope of this mission reveals the need to develop policies to integrate standardization studies in the field of land administration into the land title and cadastre system in Turkey. In this context, GDLRC developed various projects and policies in line with its vision for 2014 and organized international scientific conferences. However, in addition to this vision, the social and technological dynamics that will affect the land management in the next 20 years need to be taken into consideration. As a result of these needs, six principles for Cadastre 2034 have been determined (Bennet et al., 2010; Shojaeia et al., 2016). The main aim of Cadastre 2034 is to shape the cadastre of the future by continuing the reform process as developed in Cadastre 2014.

The task of GDLRC is to follow the technological developments and

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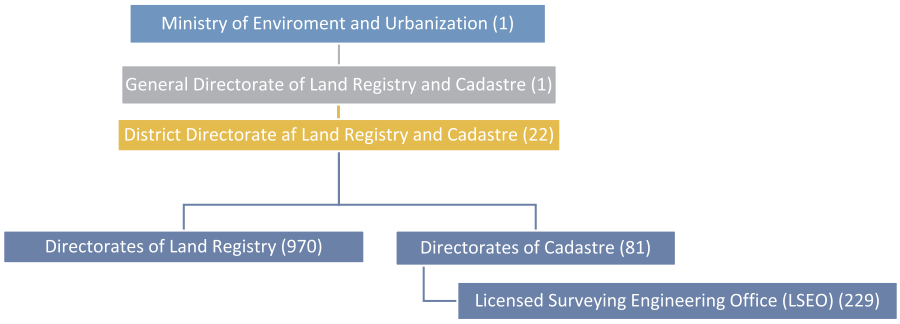

Fig. 1. Organizational structure of the Turkish land registration and cadastre system (Yomralioglu and Cete, 2015; Alkan and Polat, 2016).

changes in the field of land administration, renovation of cadastral maps and update land registry plan (Yildiz et al., 2015), and to carry out related control and supervision activities (Atak and Durduran, 2015). Strategic planning is an important method in the execution of these activities (Toksoy et al., 2009). Strategic planning is based on strategy being the determination of the current status of the institution, the operator or the company to be determined. A strengths, weaknesses, opportunities and threats (SWOT) analysis is used to determine this current status and enables organizations to adopt a realistic approach in defining missions and determining targets. This analysis is a suitable technique for identifying the internal strengths and weaknesses of the institutions that play a role in land administration and identify external opportunities and threats (Aydinoglu, 2011).

These internal and external factors are called strategic factors and constitute the SWOT analysis. They are the most important factors for the future of an institution (Kurtilla et al., 2000). Thus, by using the strengths of the institution/operator, it is possible to make better use of opportunities and reduce the impact of threats by considering their weaknesses (Kaygın et al., 2016); however, the numerical measurement of SWOT limits the analysis but this limitation can be removed by using the AHP technique (Kayin et al., 2016; Celik and Murat, 2009). The application of AHP allows for the systematic evaluation of the factors used in the SWOT analysis. The SWOT analysis provides a simple framework for a decision-status analysis and the AHP technique supports a more analytical application of the SWOT analysis (Kangas et al., 2003; Shrestha et al., 2004; Taskın and Guneri, 2005).

In order to implement the Cadastre 2034 principles, the structure of land administration in Turkey and the cadastral system must be analyzed in terms of the LIT aspects. For this purpose, the strengths, weaknesses, opportunities, and threats of the LIT dimensions of the existing land management and cadastral system regarding each principle determined in Cadastre 2034 are determined to be the result of the internal and external environment analysis. The comparison of the basic criteria determined from the LIT aspects according to the results of the SWOT analysis, the determination of the weights and effect of these criteria on the applicability of the Cadastre 2034 vision were modeled using the AHP technique and the results obtained were analyzed in terms of strategic planning.

2. Turkish cadastre and land administration system

2.1. Legal aspects

There are numerous laws, regulations, circulars, and directives that regulate the land registry and cadastral activities in Turkey (Cete, 2008); however, when considering the judgments made on the basis of laws, it appears that there are 8 cadastre and 34 land registry related laws. However, in addition, there are 3 statutes and 1000 circulars (Ercan, 2003). Although the land registry and cadastre activities seem to be regulated within a comprehensive legislation, the basic laws in this area can be said to be the Land Registry Law No. 2644 and the Cadastre Law No. 3402 (Ercan, 2003; Köktürk, 2003; Cete, 2008).

2.2. Institutional aspects

The cadastral works in Turkey are carried out by GDLRC (Cete, 2008). This institution dates back to 1847 and its current structure was determined in 1936 by the Law No. 2997. The general directorate, which has a long history of 160 years, was restructured with the Law No. 3045 dated 26.09.1984 according to the requirements of the day and called the “Law on Adoption of Decree on the Establishment and Duties of GDLRC” (Ercan, 2003). The provincial organization of GDLRC, which operates under the Ministry of Environment and Urbanization, consists of 22 regional directorates, 81 cadastral directorates, 970 land registry offices, and 229 Licensed Surveying Engineering Office (see Fig. 1). Thus, GDLRC has a strong organizational structure and the execution of land registry and cadastre activities under one roof ensures that the pre-emptive Cadastre 2014 vision that integration of land and cadastral data will be realized.

2.3. Technical aspects

The land registry and cadastre studies in Turkey have not been fully completed due to problems related to legal structure (wide legislative structure), institution (insufficient budget and technical staff), and technical aspects (use of different measurement systems). GDLRC carries out various activities and projects to achieve the completion of the country-wide cadastre system and to implement innovations in the area of land management. In this context, online updateable information system-based projects are developed in a central database, which aims to undertake the transactions of the Register and Cadastre Directorates of the Land Registry in a proper manner and in a computer environment (Mataraci, 2005) and to manage cadastral data. Among these projects, Land Registry and Cadastre Information System (TAKBIS), Spatial Property System (MEGSIS) and Map Information System projects make important contributions in terms of the online collection, sharing and management of cadastral data. The fact that cadastral maps are produced in different ways (such as Astrolon, cardboard, polyester, aluminum, diazo, paper, photograph, Ozalid, film, acetate, invertor, and linoleum), use various scales (1/20000, 1/10000, 1/5000) and different coordinate systems (digital, polar, graphical, photogrammetric, prismatic, etc.) (Kokturk, 2009; Atak and Durduran, 2015; Demir et al., 2015) and a significant amount of these maps are not based on the country triangulation network creates technical and legal bottlenecks in the development of an effective Land Registry and Cadastre Information System in Turkey (Mataraci, 2005). The cadastre maps that have been produced so far by different methods with various scales and bases, with or without coordinates, should also be converted into digital form (Demir and Coruhlu, 2008; Demir and Coruhlu, 2009). Together with technological developments, the establishment of the Turkish National Basic GPS Network (TUTGA) has opened the way for sensitive cadastral measurements. In cadastre studies, the power relations between different institutions constitutes a handicap for cadastral data measurement.

Table 1
SWOT Matrix (URL 1).

Internal elements	Organizational Strengths (**S**)	Organizational Weaknesses (**W**)
External elements	Strategic options	
Environmental Opportunities (and risks) (**O**)	**S-O:** Strengths can be used to capitalize or build upon existing or emerging opportunities	**W-O:** The strategies developed need to overcome organizational weaknesses if existing or emerging opportunities are to be exploited
Environmental Threats (**T**)	**S-T:** Strengths in the organization can be used to minimize existing or emerging threats	**W-T:** The strategies pursued must minimize or overcome weaknesses and, as far as possible, cope with threats

3. The cadastre 2034 vision

Accurate and up-to-date information access has become more important along with changing social needs due to the technological developments. It is necessary to present legally valid, fast, accurate, and authoritative cadastral data, which plays a key role in meeting economic, property, taxation, spatial planning, and land–land arrangement in terms of social needs (Matarici et al., 2009). Therefore, integrated cadastral data from different sources should be shared among many users and applications (Matarici et al., 2009).

Cadastre 2014 still offers a valid perspective for a modern cadastre. However, in addition to this vision, the social and technological dynamics that will affect the land management in the next 20 years also need to be taken into consideration (Ozcelik, 2013). To this end, Bannet and colleagues discussed basic components in the FIG congress held in Sydney in 2010 and emphasized Australia's perspective of how the cadastre system should develop towards 2034. In this context, the main points that were discussed were:

(1) ***Measurement Accuracy Based Cadastre***, which foresees high accuracy measurement in the determination of land boundaries for land.

(2) ***Object-Based Cadastre*** instead of parcel-based cadastre in which all rights, restrictions and responsibilities (RRR) of land use are re-defined and legally defined to meet today's needs. Land parcels are well defined in the fundamental cadastre but the extension to a broader set of property objects will require new ways of modelling the information. Beside the term "a land parcel" "Cadastre 2014" introduces also the term "a legal land object", i.e. the area for which specified rights are valid, independently from the extension of property rights (Wilkowski, 2010). In legal land object concept, the spatial representation of RRRs is limited. Object-Based Cadastre which identified on the 2034 vision that enables people to readily and confidently identify the location and extent of all RRRs related to land and real property.

(3) ***3D and 4D (3D + Time) Cadastre*** for the modeling, management, integration of property data and sustainability analysis of land. 4D Cadastre includes time dimension and 3D cadastre. So, there is a need to include time to reconstruct history, to manage events in maintenance processes and to reflect reality in case of temporal rights

(4) ***Updated and Real Time Cadastre*** to achieve the updating and accessing of cadastral information in real time.

(5) ***Regional and Global Cadastre,*** to be interlinked and interoperable in a regional and global sense;

(6) ***Natural Cadastre*** for a better modeling of the natural environment.

Thus, within the vision of Cadastre 2034, the aim is to provide the expected basic services from the cadastre, such as knowledge of all the rights, restrictions, and responsibilities related to the immovable properties with these components, access to property and locational content, and to direct the future cadastre with developed policies, models, and standards (Bennett, 2010a,b, 2011; Lemmens, 2010a,b; GIM, 2011; Ozcelik, 2013).

4. Research design and methodology

4.1. SWOT analysis

The SWOT analysis (Toksoy et al., 2009) first began to be used for business management in the 1970s and today it is used in many fields. SWOT is an analysis and planning tool aiming to determine the strategy for the future by examining the current situation in every direction (Kaygisiz et al., 2016). In this analysis method, it is necessary to accurately identify the threats and opportunities arising from external factors as well as the strengths and weaknesses of internal factors (Puıu et al., 2009). The strengths category in the SWOT analysis represents the areas in which organizations/institutions are more effective and efficient than competitors. The weaknesses are situations in which the organization/institutions is less efficient and effective than its competitors. By discovering the weaker side will be a step towards resolving problems that will lead to serious difficulties and limitations regarding the long-term strategies and plans of the organization. Opportunities are the favorable conditions that can be found when the strategic plan is examined and in relation to the goals that have been achieved. Threats are a new situation that makes it difficult or impossible for organizations to realize their goals; thus, impeding the success of the organization/institutions (Guldiken, 2016).

If there is an existing system as considered in the SWOT analysis structure shown in Table 1, the strengths of this system are its own resources and capabilities. The weaknesses of the system stem from the lack of capabilities and features. The process to identify the strengths and weaknesses of the system's current or future success are called internal analyses. External analyses are the methods used to reveal the possibilities of and threats to the system. In order to present the current situation in strategic plans, the SWOT matrix is created to show the current situation analysis after determining the system-related SWOT parameters. The SWOT matrix is strategic stage that emerged as a result of analyzing the internal and external factors of the system (Ucar and Dogru, 2005).

The internal and external factors of the SWOT analysis are called strategic factors and are the most important factors revealing the future of a business or industry (Kurtilla et al., 2000). The current situation analysis using the SWOT technique will help the institution, company or enterprise to evaluate itself and its environment in a more realistic manner and help prepare for the future in a healthy way (Toksoy et al., 2009).

4.2. AHP method

AHP developed by Thomas Saaty in the 1970s is a multi-criteria decision-making method used to solve complex problems (Kuruuzum and Atsan, 2001; Demir and Yilmaz, 2012). AHP allows complex problems to be solved by establishing a hierarchy of objectives-criteria-subcriteria-options. In general, AHP is based on three basic principles; problem segmentation and decomposition, comparative decision making, and synthesis of priorities (Saaty, 1977, 1980).

4.2.1. Problem partitioning and creating hierarchy (decomposition)

An objective is determined by decision making through AHP. This is a general objective that comprises multiple sub-purposes. According to the criteria to be evaluated, the decision makers consisting of groups or individuals make binary comparisons with each of the criteria (Demir and Yilmaz, 2012).

Table 2
Scales for pairwise comparison (Saaty, 2008; Safari et al., 2010).

Intensity of Importance	Explanation
1	Two criteria contribute equally to the objective
3	Experience and judgment slightly favor one over another
5	Experience and judgment strongly favor one over another
7	One criterion is strongly favored and its dominance is demonstrated in practice
9	Importance of one criterion over another affirmed on the highest possible order
2,4,6,8	Used to represent compromise between the priorities listed above

4.2.2. Comparative judgment and constructing the preference matrix (comparative judgment)

According to the criteria to be evaluated in relation to the decision options, the person or persons making the decision will undertake binary comparisons between each criterion. Thomas L. Saaty developed a scale of 1–9 for the pairwise comparison of decision criteria and decision options (Table 2). The decision criteria on this scale are evaluated with pairwise comparisons, and the decision options in binary comparisons are determined according to each decision criterion (Saaty, 1994).

4.2.3. Synthesis of priorities

As a result of this evaluation, matrices such as matrix A given below are obtained in the binary comparisons of decision options and the decision options according to each decision criterion. In comparing two criteria or decision options, the comparison value x has the opposite value $1/\boldsymbol{x}$. If $\boldsymbol{a}_{21} = 3$ $\boldsymbol{a}_{21} = 1/3$then

$$\boldsymbol{A} = \begin{bmatrix} \boldsymbol{a}_{11} & \boldsymbol{a}_{12} & \dots & \boldsymbol{a}_{1n} \\ \boldsymbol{a}_{21} & \boldsymbol{a}_{22} & \dots & \boldsymbol{a}_{2n} \\ \vdots & \vdots & & \vdots \\ \boldsymbol{a}_{n1} & \boldsymbol{a}_{n2} & \dots & \boldsymbol{a}_{nn} \end{bmatrix}$$

The comparison matrix shows the significance levels of the criteria according to each other within a certain logic. However, the column vectors that comprise the comparison matrix are used to determine the weights of all of these criteria. Using Eq. (1), n number (quantity) and n component [B] column vectors (Eq. (2)) are generated.

$$b_{\boldsymbol{ij}} = \frac{a_{ij}}{\Sigma_{i=1}^{n}\ a_{ij}} \tag{1}$$

$$\boldsymbol{B}_{\boldsymbol{i}} = \begin{bmatrix} \boldsymbol{b}_{11} \\ \boldsymbol{b}_{21} \\ \vdots \\ \boldsymbol{b}_{n1} \end{bmatrix} \tag{2}$$

When the comparison operations are repeated for all criteria, the column vector [B] will be obtained up to the criterion number. When the [B] column vector, which is formed by the number of criteria, is combined in a matrix format, a matrix [C] (Eq. (3)) will be created (Timey, 1980; Triantaphyllou and ve Mann, 1995; Matthew and ve Robert, 2003; Pillay et al., 2009).

$$\boldsymbol{C} = \begin{bmatrix} \boldsymbol{b}_{11} & \boldsymbol{b}_{12} & \dots & \boldsymbol{b}_{1n} \\ \boldsymbol{b}_{21} & \boldsymbol{b}_{22} & \dots & \boldsymbol{b}_{2n} \\ \vdots & \vdots & & \vdots \\ \boldsymbol{b}_{n1} & \boldsymbol{b}_{n2} & \dots & \boldsymbol{b}_{nn} \end{bmatrix} \tag{3}$$

The relative importance values of the criteria can be obtained using the [C] matrix generated after the completion of the comparison operations. For this, as shown in Eq. (4), the arithmetic mean of the line components that make up the matrix [C] is taken and the column vector [W] in Eq. (5) called the "Priority Vector" is obtained (Saaty 1980; Triantaphyllou and ve Mann, 1995, Matthew and ve Robert, 2003; Pillay et al., 2009). The values in this vector are the significance weights of the criteria.

$$w_{\boldsymbol{i}} = \frac{\Sigma_{i=1}^{n}\ b_{ij}}{n} \tag{4}$$

$$\boldsymbol{W} = \begin{bmatrix} \boldsymbol{w}_1 \\ \boldsymbol{w}_2 \\ \vdots \\ \vdots \\ \boldsymbol{w}_n \end{bmatrix} \tag{5}$$

Using the consistency ratio (CR) obtained by calculations of the binary comparison matrices, it is possible to test the consistency of the determined precedence vectors and thus the judgments made in the mutual comparisons found between the criteria.

In AHP, the essence of the CR calculation is based on a comparison of a coefficient (λ) called the base value with the number of criteria. (λ) is obtained by first obtaining the column vector [Eq. (6)] from the matrix multiplication of the [A] binary comparison matrix and the priority vector [W] (Timey 1980, Triantaphyllou and ve Mann, 1995, Matthew and ve Robert, 2003; Pillay et al., 2009).

$$\boldsymbol{D} = \begin{bmatrix} \boldsymbol{a}_{11} & \boldsymbol{a}_{12} & \dots & \boldsymbol{a}_{1n} \\ \boldsymbol{a}_{21} & \boldsymbol{a}_{22} & \dots & \boldsymbol{a}_{2n} \\ \vdots & \vdots & & \vdots \\ \boldsymbol{a}_{n1} & \boldsymbol{a}_{n2} & \dots & \boldsymbol{a}_{nn} \end{bmatrix} \boldsymbol{x} \begin{bmatrix} \boldsymbol{w}_1 \\ \boldsymbol{w}_2 \\ \vdots \\ \vdots \\ \boldsymbol{w}_n \end{bmatrix} \tag{6}$$

As defined in Eq. (7), the base value (E) for each evaluation factor is obtained from the partition of the corresponding [D] column vector and the column vector [W]. The arithmetic mean of these values gives the basic value of comparison (λ) (Eq. (8)).

$$\boldsymbol{E}_{\boldsymbol{i}} = \frac{\boldsymbol{d}_{\boldsymbol{i}}}{\boldsymbol{w}_{\boldsymbol{i}}} \boldsymbol{i} = 1,2, \dots, \boldsymbol{n} \tag{7}$$

$$\lambda = \frac{\Sigma_{i=1}^{n}\ E_i}{n} \quad i = 1, 2, \dots, n \tag{8}$$

The consistency indicator (CI) is calculated using Eq. (9) after (λ) is calculated. In the last stage, CI is divided into the standard correction table value, referred to as the random indicator (RI) and shown in Table 3, to obtain the CR (Eq. (10)). Here, the value corresponding to the tabulation criterion number for the RI value is selected.

$$\boldsymbol{CI} = \frac{\boldsymbol{\lambda} - \boldsymbol{n}}{\boldsymbol{n} - 1} \tag{9}$$

$$\boldsymbol{CR} = \frac{\boldsymbol{CI}}{\boldsymbol{RI}} \tag{10}$$

A CR of less than 0.10 indicates that the decisions made by the decision maker are consistent and acceptable. A CR value greater than 0.10 indicates either a calculation error in the AHP or an inconsistency in the comparison of the decision maker. In the case of inconsistency, the operations are repeated starting from the binary comparison matrices. After the consistency of the comparisons is calculated, if the judgments are correct, each measure must be evaluated in terms of alternatives to be decided upon.

At this point in the process, alternatives need to be evaluated for each criterion. These reciprocal comparisons yield the matrices of m x m (m: alternative number) [G]. After completing the reciprocal comparison operations, the matrix normalization is obtained by arithmetic or geometric averaging to gain n × S dimensional column vectors with significance distributions according to the evaluated metric alternatives (Eq. (11)). Unlike the arithmetic and geometric mean for the normalization process, the high order of the comparison matrix can be obtained.

$$S_i = \begin{bmatrix} s_{11} \\ s_{21} \\ \vdots \\ \vdots \\ s_{m1} \end{bmatrix} \quad (11)$$

After building the S column matrices up to the number of criteria (n), an m x n dimension [K] decision matrix is formed from the [S] column vector of size n, m x 1, (Eq. (12)).

$$K = \begin{bmatrix} s_{11} & s_{12} & \cdots & s_{1n} \\ s_{21} & s_{22} & \cdots & s_{2n} \\ \vdots & \vdots & & \vdots \\ s_{m1} & s_{m2} & \cdots & s_{mn} \end{bmatrix} \quad (12)$$

When the [K] decision matrix is multiplied by the priority vector [W], the vector of m elements [L] giving the significance of the alternatives is obtained (Eq. (13)). The sum of the elements of the [L] column vector must be 1. These values indicate the order of significance of the decision points or alternatives.

$$L = \begin{bmatrix} s_{11} & s_{12} & \cdots & s_{1n} \\ s_{21} & s_{22} & \cdots & s_{2n} \\ \vdots & \vdots & & \vdots \\ s_{m1} & s_{m2} & \cdots & s_{mn} \end{bmatrix} x \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} = \begin{bmatrix} l_{11} \\ l_{21} \\ \vdots \\ l_{m1} \end{bmatrix} \quad (13)$$

4.3. Combined SWOT and AHP

The strategic management technique of SWOT, which involves internal and external situation analyses of an institution or company, requires extensive research of the target factors (Aktan, 2007). These factors are classified into the four groups of strengths, weaknesses, opportunities, and threats; however, the importance of these factors cannot be measured numerically within the analysis. To remove this limitation, AHP is employed. This is also referred to as a digitized SWOT analysis and is performed in the following steps (Kangas et al., 2001; Tahernejad et al., 2013):

Step 1. Identification of the SWOT sub-factors and selection of alternative strategies according to these sub-factors.

Step 2. Developing the AHP hierarchy, in which the problem to be solved is divided into a hierarchical structure in terms of decision components (goal, criteria, sub-criteria, and alternatives) (Fig. 2). The main objective of transforming this hierarchical structure is to ensure that the alternatives are measured with AHP (Tahernejad et al., 2013; Yuksel and Dagdeviren, 2007).

Step 3. Performing pairwise comparisons between the SWOT factors separately in each SWOT group. The aim of the comparisons is to determine which of the two compared factors is more important. By taking the comparisons as inputs, the relative priorities of the factors are determined. For this, a pairwise comparison matrix is determined between the factors (Eq. (14)).

$$A = \begin{bmatrix} 1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & 1 & \cdots & w_2/w_n \\ \vdots & \vdots & \vdots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & 1 \end{bmatrix} \quad (14)$$

Where A = comparison pairwise matrix, w_1 = weight of element 1, w_2 = weight of element 2 and w_n = weight of element n.

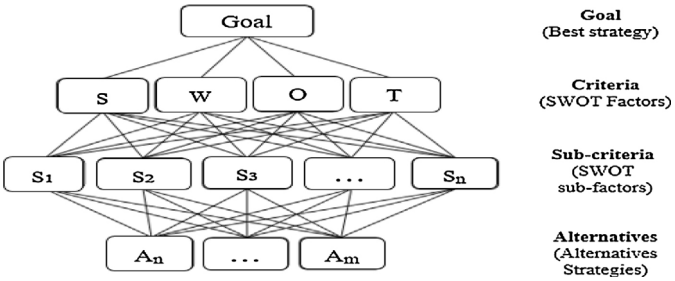

Fig. 2. The hierarchical structure representation of the SWOT model.

In order to determine the comparison pairwise matrix, the importance of the criteria must be measured. For this, the scale developed by Saaty is used (see Table 1).

Step 4. Determining the priorities of the SWOT factors, local importance degrees of the SWOT subfactors, and importance degrees of the alternative strategies with respect to each SWOT subfactor. The eigenvalue is used to calculate the relative weights (Tahernejad et al., 2013; Lee et al., 2008). The relative weights (W) of matrix A are obtained from Eq. (15).

$$(A - \lambda_{max} I) x W = 0 \quad (15)$$

Where I = unit matrix and λ_{max} = the biggest eigenvalue of matrix A

The inconsistency in the comparison pairwise matrix is a situation that can be expected up to a certain value. For this reason, the method predicts that the level of inconsistency is less than 0.10 (Yuksel and Akin, 2006). The calculation of the consistency ratio (CR) (see Eq. (17)) depends on the calculation of the consistency index (CI) (see Eq. (16)) and the random index (RI) (see Table 2).

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (16)$$

$$CR = \frac{CI}{RI} \quad (17)$$

RI is determined based on the number of criteria 'n' (see Table 2). Accordingly, the inconsistency rate is the RI portion of CI. If $CR \leq 0.1$, the model is consistent. If the consistency ratio increases by 0.1, the process is repeated and a reasonable value of the consistency rate is obtained.

Step 5. Calculating the global importance degrees of the SWOT subfactors (Eq. (18)).

$$W_{subfactors(global)} = W_{factors} x W_{subfactors(local)} \quad (18)$$

where $W_{subfactors(global)}$ is a matrix that denotes the global importance degrees of the SWOT subfactors, $W_{factors}$ is a matrix that denotes the priorities of the SWOT factors, and $W_{subfactors(local)}$ is a matrix that denotes the local importance degrees of the SWOT subfactors.

Step 6. Determining the overall priorities of the alternative strategies (Eq. (19)).

$$W_{alternatives} = W_1 x W_{subfactors(global)} \quad (19)$$

where W_1 is a matrix that denotes the importance degrees of the alternative strategies with respect to each SWOT subfactor.

Table 3
Random index (RI).

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Table 4
Cadastre 2034 Vision Principles.

P1-Survey-accuracy cadastre	**P4**- Updated and real-time cadastre
P2- Object-oriented cadastre	**P5**-National and international cadastre
P3-3D and 4D cadastre	**P6**- Green and nature cadastre

5. Application of the SWOT–AHP approach

The land administration and cadastral system of Turkey was analyzed according to the internal and external factors in the SWOT analysis in accordance with the principles of Cadastre 2034. Experts in the field of the land administration and cadastre were the participants in the SWOT analysis. The experts are consists of lawyers, officer, academicians. Pairwise comparison matrixs are made face to face with these experts. Scales for pairwise comparison (Table 2) are used to generate these pairwise comparison matrixs. Then, the pairwise comparison matrixs are used in SWOT analysis. As a result of the analysis, the strengths and weaknesses (internal factors) and threats-opportunities (external factors) were identified as the main factors in the legal, institutional, and technical aspects. Sub-factors were also determined in relation to the main factors. Based on the cadastre 2034 principles listed in Table 4, the Cadastre 2034 principle/principles (P_n) associated with each sub-factor is indicated in parentheses at the end of the text related to sub-factors (See Table 5). The SWOT-AHP steps given in Section 4.3 were applied to the LIT aspects individually, and the results are examined in the Results and Discussion section of this paper.

5.1. Application of the SWOT–AHP approach to the legal aspect

Step 1 and 2. The SWOT analysis sub-factors were defined in terms of the legal aspect (Table 5) and alternative strategies were determined according to these sub-factors (Table 6). The pairwise comparison matrix for the SWOT group at the first level of the AHP model and the local weights for each group are given in Table 7. As a result of the resolution of the pairwise comparison matrix for the SWOT group, the weights of strengths, weaknesses, opportunities, and threats were determined as 37%, 15%, 36%, and 12%, respectively.

The inconsistency ratio of the pairwise comparison matrix for the SWOT group factors was calculated as 0.06. This rate indicates that the pairwise comparison matrix is consistent. Table 6 shows strengths, weaknesses, opportunities, and threats identified by the SWOT group in terms of LIT aspects, and these weights (see Table 7) are used in the calculations of SWOT analysis sub-factors.

Step 3 and 4. The pairwise comparisons matrix was determined according to the SWOT sub-factors determined in terms of the legal aspect (See Appendix A, Tables A1–A4). The CRs and the local weights of the elements of the pairwise comparison matrix were calculated as given in Appendix A, Tables A1–A4.

Step 5 and 6. Using the local weights of the sub-factors given in Appendix A, Tables A1–A4 and the weights of the SWOT groups presented in Table 7, the global importance degrees of the SWOT sub-factors were calculated according to Eq. (18) (see Table 12). Then, the weights of alternative strategies were calculated using the

Table 5
Main and sub factors of SWOT in the legal aspect.

Strengths (S)	Weaknesses (W)
S_1: Large-Scale Map and Map Information Production Regulation (P1)	**W_1**: Long standing cadastre cases (P1,P4)
S_2: Turkish Civil Code numbered 4721 (P2,P3)	**W_2**: The existence of broad and complex laws, circulars and regulations (P1,P2,P3)
S_3: Cadastre Law No. 3402 (P2,P3)	**W_3**: Not fully defined for object-oriented cadastre (P2)
S_4: Implementing Regulation on the Sharing of Land Registry and Cadastre Data (P4)	**W_4**: Absence of clear definitions in legislation related to the 3D and 4D cadastre (P3)
S_5: Article 35 of the Land Registry Law No. 2644 (P5)	**W_5**: Prohibition of second cadastre (P4)
S_6: Legislation for the protection of underground and surface resources (P6)	**W_6**: The lack of significant legal framework for cadastre activities at the global level (P5)
S_7: Legal protection of property rights (P1,P2,P3,P4,P5,P6)	**W_7**: Article 2/b of Forest Law No 6831 (P6)
Opportunities (O)	**Threats (T)**
O_1: The development of international land management standards and the re-regulation of countries' legislation accordingly (P2,P3,P5)	**T_1**: Work load density of jurisdiction and extending property cases (P1,P4)
O_2: The assumption that the national resources on the earth are international public goods (P5,P6)	**T_2**: Lack of specialist jurists and experts in land administration and cadastre (P1–P4)
O_3: International manifestos and declarations (P2–P5)	**T_3**: The existence of country-specific law rules (P5,P6)
O_4: Cadastre 2014 Vision (P1–P3)	**T_4**: Different management mentality and level of development in the countries (P5,P6)
O_5: Adoption of INSPIRE Directives (P1–P4)	**T_5**: No legal reforms required in the field of Country land management (P2–P4)
O_6: ISO 19512 Land Administration Domain Model (P2–P5)	**T_6**: Lack of legal infrastructure (P2–P4)
O_7: Efforts to harmonize the legislation with international standards (P5,P6)	**T_7**: The existence of different laws that restrict land administration and cadastre activities (P5,P6)

Table 6
Strategic alternatives related to the SWOT sub-factors identified in the legal aspect.

Internal elements	Organizational Strengths (S_n)	Organizational Weaknesses (W_n)
External elements	Strategic alternatives	
Environmental Opportunities (O_n)	**S-O:** Providing enterprise-level participation in the international standardization studies	**W-O:** Training of expert jurists in the field of land administration and cadastre
Environmental Threats (T_n)	**S-T:** Improving the legal infrastructure to accelerate the decision-making process for property cases	**W-T:** Updating the land administration legislation according to the conditions of the day

Table 7
Pairwise comparisons of the SWOT factors related to the LIT aspects.

SWOT Goups related legal, institutional and technical aspect	S	W	O	T	Importance Degrees of SWOT Groups related legal, institutional and technical aspect
Strengths (S)	1.000	3.000	1.000	3.000	0.37
Weaknesses (W)	0.333	1.000	0.250	2.000	0.15
Opportunities (O)	1.000	4.000	1.000	2.000	0.36
Threats (T)	0.333	0.500	0.500	1.000	0.12
CR = 0.06					

alternative strategies proposed for the legal aspect with a pairwise comparisons matrix according to the SWOT sub-factors (W_1). The total priorities of alternative strategies ($W_{alternatives}$) were calculated as a result of the multiplication of the W_1 matrix and the matrix of general significance ratings of SWOT sub-factors ($W_{subfactors\text{-}global}$) according to Eq. (19).

$$W_1 = \begin{bmatrix} 0,29 & 0,07 & 0,06 & 0,08 & 0,40 & 0,08 & 0,07 & 0,07 & 0,07 & 0,07 & 0,10 & 0,07 & 0,51 & 0,06 & 0,55 & 0,51 & 0,56 & 0,60 & 0,51 & 0,54 & 0,58 & 0,06 & 0,05 & 0,53 & 0,50 & 0,06 & 0,05 & 0,06 \\ 0,10 & 0,34 & 0,31 & 0,27 & 0,13 & 0,28 & 0,52 & 0,46 & 0,40 & 0,35 & 0,42 & 0,25 & 0,13 & 0,28 & 0,14 & 0,13 & 0,12 & 0,13 & 0,17 & 0,15 & 0,14 & 0,39 & 0,14 & 0,12 & 0,14 & 0,40 & 0,54 & 0,40 \\ 0,21 & 0,18 & 0,29 & 0,17 & 0,20 & 0,16 & 0,14 & 0,16 & 0,15 & 0,22 & 0,17 & 0,14 & 0,08 & 0,15 & 0,07 & 0,07 & 0,06 & 0,07 & 0,06 & 0,07 & 0,06 & 0,25 & 0,61 & 0,07 & 0,08 & 0,14 & 0,14 & 0,14 \\ 0,40 & 0,41 & 0,34 & 0,49 & 0,26 & 0,48 & 0,27 & 0,31 & 0,38 & 0,37 & 0,31 & 0,54 & 0,28 & 0,51 & 0,25 & 0,28 & 0,26 & 0,21 & 0,26 & 0,25 & 0,22 & 0,30 & 0,19 & 0,28 & 0,28 & 0,40 & 0,27 & 0,40 \end{bmatrix}$$

$$W_{alternatives} = \begin{bmatrix} SO \\ ST \\ WO \\ WT \end{bmatrix} = W_1 X W_{subfactors(global)} = \begin{bmatrix} 0,28 \\ 0,27 \\ 0,15 \\ 0,30 \end{bmatrix}$$

5.2. Application of the SWOT–AHP approach to the institutional aspect

Steps 1 and Step 2: The SWOT sub-factors were defined for the institution (Table 8) and alternative strategies were determined according to these sub-factors (Table 9). The binary comparison matrix for the SWOT group at the first level of the AHP model and the local weights of each group are given in Table 7.

Table 9
Strategic alternatives related to SWOT sub-factors identified in the institutional aspect.

Internal elements	Organizational Strengths (S_n)	Organizational Weaknesses (W_n)
External elements	Strategic alternatives	
Environmental Opportunities (O_n)	**S-O:** Providing consultancy services based on institutional experience	**W-O:** Development of cooperation with public and private sector in line with institutional needs
Environmental Threats (T_n)	**S-T:** Supporting projects for service provision via e-government	**W-T:** Expansion of in-service training for qualified staff

Step 3 and 4. The binary comparative matrices between the SWOT sub-factors determined from an institutional perspective were obtained (See Appendix B, Tables B1–B4). CR and the local weights of the elements of the binary comparison matrix were calculated and are shown in Appendix B, Tables B1–B4.

Step 5 and 6. Using the weights of the SWOT groups in Table 7 and the local weights of the sub-factors in Appendix B, Tables B1–B4, the general significance ratings of the SWOT sub-factors according to Eq. (18) were calculated (see Table 13). Alternative strategies were then calculated using the binary comparison matrices according to the SWOT sub-factors (W1). The total priorities of alternative strategies were calculated as a result of multiplying matrix (W1) and the SWOT sub-factors by the matrix of the general significance scores according to Eq. (19).

Table 8
SWOT main and sub factors in the institutional aspect.

Strengths (S)	Weaknesses (W)
S_1: The existence of single responsible institution related to land registry and cadastre activities (P4–P6) **S_2**: The existence of strong corporate budget (P1–P4) **S_3**: The existence of rooted corporate experience (P1–P4) **S_4**: A common organizational structure (P1–P4) **S_5**: The existence of TSE ISO EN 9001-2008 Quality Certificate at institutional level (P1–P5) **S_6**: Opportunity to make land registry and cadastre process from abroad (P4,P5) **S_7**: counsel to foreign countries with professional and technical knowledge (P5)	**W_1**: Inadequacies in control and inspection (P1,P4) **W_2**: Lack of skilled and specialized personnel (P1–P4) **W_3**: Inadequacies in vocational retraining (P1–P4) **W_4**: Number of personnel that do not increase at the same rate depending on increased transaction volume and diversity (P1,P2,P3,P4) **W_5**: No effective human resources policy (P1–P4) **W_6**: The organizational law and its structure can not meet institutional needs (P1–P4) **W_7**: Lack of trained personnel in terms of international land administration law (P5,P6)
Opportunities (O)	**Threats (T)**
O_1: Development of cooperation with non-governmental organizations, public and private sector (P1–P4) **O_2**: Trained human resource (P1–P4) **O_3**: Directions in the EU harmonization process (P2,P3,P5) **O_4**: The existence of international standardization activities such as ISO and OGC (P2,P3,P5) **O_5**: The possibility of using foreign financing loans more (P3,P4,P5) **O_6**: Development of e-government automation projects (P4,P5) **O_7**: Dissemination of database based management information system (P1–P4)	**T_1**: Realization of cadastral activities in part by other institutions outside GDLRC (P1–P4) **T_2**: Lack of collaboration and data sharing between institutions both globally and nationally level(P4,P5) **T_3**: No effective national land management policy (P1–P4) **T_4**: Slowing down EU harmonization process (P5) **T_5**: Political and economic instability in the region and the world (P5,P6) **T_6**: GDLRC can not get enough share from general budget (P1–P4) **T_7**: No sustainable national land management policy (P1–P4)

Table 10
The SWOT main and sub factors in relation to the technical aspect.

Strengths (S)	Weaknesses (W)
S_1: Completion of TAKBIS, MEGSIS, TUCBS, HBB, TUSAGA-ACTIVE projects (P1–P4) **S_2**: Completion of transition to TAKBIS throughout the country (P1–P4) **S_3**: The existence of strong archive structure (P1,P4) **S_4**: Access to information related to parcels via e-government (P4) **S_5**: Continuous project development for research and development activities and innovation purposes (P1–P4) **S_6**: Completion of transition to online appointment system at all directorates (P4) **S_7**: Online and offline data sharing (P4,P5)	**W_1**: Use of different measuring, base and coordinate systems (P1,P2,P3,P4) **W_2**: Errors resulting from measurements, limitations, plotting and calculations (P1,P4) **W_3**: Not to transfer the land registry and cadastre information to the totally digital medium due to the shortcomings of the transition to digital information from the graph information (P1–P4) **W_4**: 2D cadastral measurement and recording not completed 100% (P1,P2,P3,P4) **W_5**: Continuation of parcel-based cadastre (P1–P4) **W_6**: Failure to complete the transition to an object-oriented database and inadequate infrastructure (P2,S4) **W_7**: Problems in the detection, restraint, and appropriation of summer pasture, leas, winter quarters and the places where the forest has lost its qualities, (P1,P4,P6)
Opportunities (O)	**Threats (T)**
O_1: Developing measurement techniques in terms of technically and technologically (P1–P4) **O_2**: Increasing need for Spatial Information Management System (P1–P4) **O_3**: The development of satellite and mobile technologies and the ability to collect spatial data regardless of distance (P1,P3–P5) **O_4**: Technological developments related to 3D data acquisition and display (P3) **O_5**: The power of the private sector (P1–P4) **O_6**: Data management and data security with relational database (P2) **O_7**: Widespread inter-sectoral relations with information and communication technology (P1–P4)	**T_1**: Difficulties in data provision from different institutions (P4,P5) **T_2**: Disappearance of natural boundaries because of disasters (P1,P4,P6) **T_3**: Prohibition of second time cadastre (P4) **T_4**: Vertical expansion in urban areas (P3) **T_5**: High cost of three-dimensional data collection (P3–P5) **T_6**: Need for outsourced software related to software management (P1–P4) **T_7**: Risks in data sharing in the digital environment (P4)

Table 11
Strategic alternatives related to the SWOT sub-factors identified in the technical aspect.

Internal elements	Organizational Strengths (S_n)	Organizational Weaknesses (W_n)
External elements	Strategic alternatives	
Environmental Opportunities (O_n)	**S-O:** Developing the necessary infrastructure for the online delivery of corporate services	**W-O:** Completion of the country cadastre and acceleration of the transition to object-based cadastre
Environmental Threats (T_n)	**S-T:** Making it possible to legalize a second cadastre	**W-T:** Use of technical and technological measurement techniques in spatial data collection

Table 12
Overall priority of the SWOT subfactors realted to the legal aspects.

SWOT group	Group weight score	SWOT sub factors	Local priorities	Overall priorities
Strengths (S)		**S_1** Large-Scale Map and Map Information Production Regulation	0.05	0.02
		S_2 Turkish Civil Code numbered 4721	0.24	0.09
		S_3 Cadastre Law No. 3402	0.13	0.05
	0.37	**S_4** Implementing Regulation on the Sharing of Land Registry and Cadastre Data	0.06	0.02
		S_5 Article 35 of the Land Registry Law No. 2644	0.11	0.04
		S_6 Legislation for the protection of underground and surface resources	0.06	0.02
		S_7 Legal protection of property rights	0.35	0.11
Weaknesses (W)		**W_1** Long standing cadastre cases	0.13	0.02
		W_2 The existence of broad and complex laws, circulars and regulations	0.21	0.03
		W_3 Not fully defined for object-oriented cadastre	0.06	0.01
	0.15	**W_4** Absence of clear definitions in legislation related to the 3D and 4D cadastre	0.20	0.03
		W_5 Prohibition of second cadastre	0.26	0.04
		W_6 The lack of significant legal framework for cadastre activities at the global level	0.06	0.01
		W_7 Article 2/b of Forest Law No 6831	0.07	0.01
Opportunities (O)		**O_1** The development of international land management standards and the re-regulation of countries' legislation accordingly	0.18	0.06
		O_2 The assumption that the national resources on the earth are international public goods	0.05	0.02
	0.36	**O_3** International manifestos and declarations	0.13	0.05
		O_4 Cadastre 2014 Vision	0.19	0.07
		O_5 Adoption of INSPIRE Directives	0.09	0.03
		O_6 ISO 19512 Land Administration Domain Model	0.23	0.08
		O_7 Efforts to harmonize the legislation with international standards	0.15	0.05
Threats (T)		**T_1** Work load density of jurisdiction and extending property cases	0.11	0.01
		T_2 Lack of specialist jurists and experts in land administration and cadastre	0.16	0.02
		T_3 The existence of country-specific law rules	0.04	0.00
	0.12	**T_4** Different management mentality and level of development in the countries	0.05	0.01
		T_5 No legal reforms required in the field of country land management	0.11	0.01
		T_6 Lack of legal infrastructure	0.19	0.02
		T_7 The existence of different laws that restrict land administration and cadastre activities	0.34	0.04

Table 13
Overall priority of the SWOT subfactors realted to the institutional aspects.

SWOT group	Group weight score	SWOT sub factors	Local priorities	Overall priorities
Strengths (S)		S_1 The existence of single responsible institution related to land registry and cadastre activities	0.36	0.13
		S_2 The existence of strong corporate budget	0.13	0.05
		S_3 The existence of rooted corporate experience	0.17	0.06
	0.37	S_4 A common organizational structure	0.15	0.06
		S_5 The existence of TSE ISO EN 9001-2008 Quality Certificate at institutional level	0.08	0.03
		S_6 Opportunity to make land registry and cadastre process from abroad	0.06	0.02
		S_7 Counsel to foreign countries with professional and technical knowledge	0.04	0.01
Weaknesses (W)		W_1 Inadequacies in control and inspection	0.31	0.05
		W_2 Lack of skilled and specialized personnel	0.16	0.02
	0.15	W_3 Inadequacies in vocational retraining	0.18	0.03
		W_4 Number of personnel that do not increase at the same rate depending on increased transaction volume and diversity	0.13	0.02
		W_5 No effective human resources policy	0.07	0.01
		W_6 The organizational law and its structure can not meet institutional needs	0.10	0.02
		W_7 Lack of trained personnel in terms of international land administration law	0.05	0.01
Opportunities (O)		O_1 Development of cooperation with non-governmental organizations, public and private sector	0.32	0.12
		O_2 Trained human resource	0.23	0.08
		O_3 Directions in the EU harmonization process	0.09	0.03
	0.36	O_4 The existence of international standardization activities such as ISO and OGC	0.07	0.03
		O_5 The possibility of using foreign financing loans more	0.09	0.03
		O_6 Development of e-government automation projects	0.17	0.06
		O_7 Dissemination of database based management information system	0.03	0.01
Threats (T)		T_1 Realization of cadastral activities in part by other institutions outside GDLRC	0.36	0.04
		T_2 Lack of collaboration and data sharing between institutions both globally and nationally level	0.10	0.04
		T_3 No effective national land management policy	0.08	0.01
	0.12	T_4 Slowing down EU harmonization process	0.05	0.01
		T_5 Political and economic instability in the region and the world	0.04	0.01
		T_6 GDLRC can not get enough share from general budget	0.26	0.03
		T_7 No sustainable national land management policy	0.11	0.01

Table 14
Overall priority of the SWOT subfactors realted to the technical aspects.

SWOT group	Group weight score	SWOT sub factors	Local priorities	Overall priorities
Strengths (S)		S_1 Completion of TAKBIS, MEGSIS, TUCBS, HBB, TUSAGA-ACTIVE projects	0.25	0.09
		S_2 Completion of transition to TAKBIS throughout the country	0.13	0.05
		S_3 The existence of strong archive structure	0.08	0.03
	0.37	S_4 Access to information related to parcels via e-government	0.09	0.03
		S_5 Continuous project development for research and development activities and innovation purposes	0.15	0.06
		S_6 Completion of transition to online appointment system at all directorates	0.14	0.05
		S_7 Online and offline data sharing	0.16	0.06
Weaknesses (W)		W_1 Use of different measuring, base and coordinate systems	0.29	0.04
		W_2 Errors resulting from measurements, limitations, plotting and calculations	0.23	0.03
		W_3Not to transfer the land registry and cadastre information to the totally digital medium due to the shortcomings of the transition to digital information from the graph information	0.17	0.03
	0.15	W_4 2D cadastral measurement and recording not completed 100%	0.09	0.01
		W_5 Continuation of parcel-based cadastre	0.12	0.02
		W_6 Failure to complete the transition to an object-oriented database and inadequate infrastructure	0.06	0.01
		W_7 Problems in the detection, restraint, and appropriation of summer pasture, leas, winter quarters and the places where the forest has lost its qualities	0.04	0.01
Opportunities (O)		O_1 Developing measurement techniques in terms of technically and technologically	0.18	0.06
		O_2 Increasing need for spatial information management system	0.22	0.08
		O_3 The development of satellite and mobile technologies and the ability to collect spatial data regardless of distance	0.15	0.05
	0.36	O_4 Technological developments related to 3D data acquisition and display	0.24	0.09
		O_5 The power of the private sector	0.05	0.02
		O_6 Data management and data security with relational database	0.13	0.05
		O_7 Widespread inter-sectoral relations with information and communication technology	0.03	0.01
Threats (T)		T_1 Difficulties in data provision from different institutions	0.04	0.00
		T_2 Disappearance of natural boundaries because of disasters	0.29	0.03
		T_3 Prohibition of second time cadastre	0.27	0.03
	0.12	T_4 Vertical expansion in urban areas	0.05	0.01
		T_5 High cost of three-dimensional data collection	0.16	0.02
		T_6 Need for outsourced software related to software management	0.08	0.01
		T_7 Risks in data sharing in the digital environment	0.11	0.01

$$W_1 = \begin{bmatrix} 0,54 & 0,07 & 0,54 & 0,54 & 0,55 & 0,44 & 0,65 & 0,13 & 0,07 & 0,05 & 0,07 & 0,05 & 0,06 & 0,05 & 0,05 & 0,27 & 0,08 & 0,51 & 0,07 & 0,07 & 0,10 & 0,59 & 0,23 & 0,06 & 0,06 & 0,06 & 0,25 & 0,06 \\ 0,07 & 0,53 & 0,26 & 0,16 & 0,13 & 0,31 & 0,11 & 0,17 & 0,18 & 0,15 & 0,14 & 0,14 & 0,13 & 0,13 & 0,13 & 0,06 & 0,52 & 0,26 & 0,56 & 0,63 & 0,56 & 0,11 & 0,12 & 0,22 & 0,27 & 0,17 & 0,07 & 0,18 \\ 0,25 & 0,13 & 0,12 & 0,23 & 0,08 & 0,15 & 0,20 & 0,17 & 0,17 & 0,18 & 0,60 & 0,20 & 0,30 & 0,34 & 0,34 & 0,15 & 0,27 & 0,14 & 0,24 & 0,23 & 0,26 & 0,24 & 0,60 & 0,44 & 0,43 & 0,56 & 0,57 & 0,54 \\ 0,14 & 0,27 & 0,07 & 0,07 & 0,25 & 0,09 & 0,04 & 0,52 & 0,58 & 0,62 & 0,19 & 0,60 & 0,51 & 0,48 & 0,57 & 0,51 & 0,13 & 0,09 & 0,14 & 0,07 & 0,07 & 0,06 & 0,05 & 0,28 & 0,24 & 0,20 & 0,11 & 0,22 \end{bmatrix}$$

$$W_{alternatives} = \begin{bmatrix} SO \\ ST \\ WO \\ WT \end{bmatrix} = W_1 X W_{subfactors(global)} = \begin{bmatrix} 0,25 \\ 0,21 \\ 0,26 \\ 0,28 \end{bmatrix}$$

5.3. Application of the SWOT–AHP approach to the technical aspect

Steps 1 and 2. The technical SWOT sub-factors were defined (Table 10) and alternative strategies were determined according to these sub-factors (Table 11). The binary comparison matrix for the SWOT group at the first level of the AHP model and the local weights of each group are given in Table 7.

Steps 3 and 4. Binary comparison matrices between SWOT sub-factors determined from the technical standpoint were obtained (see Appendix C, Tables C1–C4). The CRs for the local weights of the binary comparison matrix elements were calculated and are shown in Appendix C, Tables C1–C4.

Steps 5 and 6. Using the weights of the SWOT groups in Table 7 and the local weights of the sub-factors in Appendix C, Tables C1–C4, the general significance ratings of the SWOT sub-factors according to Eq. (18) were calculated (see Table 14). Then alternative strategies based on technically suggested strategies and weights of alternative strategies were calculated using the binary comparison matrices according to the SWOT sub-factors (W_1). The total priorities of alternative strategies were calculated as a result of multiplying matrix (W_1) and the SWOT sub-factors by the matrix of general significance scores according to Eq. (19).

$$W_1 = \begin{bmatrix} 0,56 & 0,43 & 0,59 & 0,59 & 0,62 & 0,63 & 0,55 & 0,56 & 0,05 & 0,27 & 0,05 & 0,05 & 0,06 & 0,05 & 0,24 & 0,14 & 0,20 & 0,12 & 0,15 & 0,41 & 0,56 & 0,60 & 0,05 & 0,07 & 0,08 & 0,38 & 0,46 & 0,56 \\ 0,11 & 0,07 & 0,07 & 0,23 & 0,06 & 0,05 & 0,13 & 0,11 & 0,14 & 0,07 & 0,22 & 0,24 & 0,25 & 0,29 & 0,06 & 0,07 & 0,05 & 0,07 & 0,06 & 0,06 & 0,06 & 0,08 & 0,15 & 0,17 & 0,25 & 0,08 & 0,06 & 0,06 \\ 0,06 & 0,25 & 0,08 & 0,13 & 0,09 & 0,13 & 0,08 & 0,06 & 0,23 & 0,13 & 0,60 & 0,58 & 0,57 & 0,54 & 0,13 & 0,20 & 0,13 & 0,23 & 0,24 & 0,12 & 0,12 & 0,14 & 0,24 & 0,54 & 0,53 & 0,10 & 0,14 & 0,10 \\ 0,27 & 0,25 & 0,26 & 0,05 & 0,22 & 0,20 & 0,25 & 0,27 & 0,58 & 0,53 & 0,13 & 0,13 & 0,12 & 0,12 & 0,57 & 0,59 & 0,62 & 0,58 & 0,55 & 0,41 & 0,26 & 0,18 & 0,56 & 0,22 & 0,14 & 0,44 & 0,34 & 0,28 \end{bmatrix}$$

$$W_{alternatives} = \begin{bmatrix} SO \\ ST \\ WO \\ WT \end{bmatrix} = W_1 X W_{subfactors(global)} = \begin{bmatrix} 0,35 \\ 0,09 \\ 0,18 \\ 0,38 \end{bmatrix}$$

6. Results and discussion

6.1. Legal aspect

The pairwise comparison of the main and sub-criteria of the SWOT analysis group from the legal perspective is given in Appendix A, Tables A1–A4. The weights obtained as a result of the model solution are shown in detail in Table 12 for both the main and sub-criteria. The local weights in Table 12 are the values found in the result of the pairwise comparison for each factor. The general weights are the shares of the SWOT analysis group factors of the total weight. The main criteria of the SWOT analysis are strengths 37%, weaknesses 15%, opportunities 36%, and threats 12% weighted by the solution of the pairwise comparison matrix (Table 12). CR was calculated as 0.06. This result shows that the matrix is consistent and that the strengths of the land management and cadastre system in Turkey (37%) and the opportunities for outsourcing (36%) are more dominant than the other factors.

The local weights of factors that constitute the sub-criteria of strengths were;35% for legal protection of the property right, 24% for the existence of the Turkish Civil Code No. 4721, 13% for the existence of the Cadastre Law No. 3402, 11% for the 35th article of the No 2644 Title Law, 6% for the existence of the Regulation on the Sharing of Deeds and Cadastral Data, 6% for legislation for the protection of underground and overground resources, and 5% for Large Scale Map and Map Information Production Regulations. As shown in Appendix A, Tables A1, CR was calculated as 0.05. These results reveal that the most powerful aspect of the land administration and cadastral system in Turkey is the legal guarantee of the property right.

The local weights of the factors that constitute the sub-criteria of the weaknesses were; 26% for prohibition of a second cadastre, 21% for existence of large and complicated laws, circulars and regulations, 20% for lack of clear definitions in legislation on 3rd and 4th dimension, 13% for long cadastre cases, 7% for the 2/b article of Forest Law", 6% for "inadequate definition of object-based cadastre, and 6% for no global legal framework for cadastral activities at the global level. CR was calculated as 0.07 (see Appendix A, Tables A2). According to this result, the weakest point of the land administration and cadastral system in Turkey is the prohibition of a second cadastre.

The local weights of the factors that constitute the sub-criteria of the opportunities that arose in relation to the external environment were calculated as 23% for the land administration domain model, 19% for Cadastre 2014 vision, 18% for the development of international land management standards and rearranging the legislation of the countries accordingly, 15% for the works to harmonize legislation with international standards, 13% for International Declarations and Declarations, 9% for the adoption of INSPIRE directives, and 5% for the assumption that the national resources on the earth are international public goods. CR was calculated as 0.07 (see Appendix A, Tables A3). According to this result, the existence of the land administration domain model is the most important opportunity for the land administration and cadastre system in Turkey and this is related to the external environment. Current International land management standards provide opportunities to design sustainable land management. Because of economical and organisational challenge, these standards are not always easily implemented in an organization. These standardization process can be accelerated with suitable institutional strategies

The LADM standard (ISO 19152) is conceptual and is to be a tool for describing legal systems with parties executing ownership, use-rights, and other RRRs and the relation to spatial units. In the short term, ımplementing this standard in Turkey may not be enough to solve institutional problems and data sharing difficulty. In the long term, presentation of spatial data at the institutional level will be provided with e-government projects such as ATLAS and TUCBS.

The local weights of the factors that constitute the sub-criteria of the threats arising from the external environment were calculated as 34% for the existence of different laws limiting land management and cadastre activities, 19% for the lack of legal infrastructure, 16% for the lack of expert jurists and experts in land administration and cadastre, 11% for the redundancy of workload and prolonged property cases, 11% for there being no legal reforms in the field of land management,

5% for the different levels of management and development in countries, and 4% for countries having their own legal rules. CR was calculated as 0.08 (see Appendix A, Tables A4). According to this result, the existence of different laws restricting land administration and cadastral activities is the most important threat arising out of the external environment for the land administration and cadastre system in Turkey.

6.2. Institutional aspect

The pairwise comparison of the main and sub-criteria of SWOT analysis group from the institutional perspective is given in Appendix B, Tables B1–B4. The weights obtained from the model solution are shown in detail in Table 13 for both the main and sub-criteria. The local weights in Table 13 are the values found in the result of the pairwise comparison for each factor. The general weights are the shares of the SWOT analysis group factors in the total weight. The strengths, weaknesses, opportunities, and threats were weighted by 37%, 15%, 36%, and 12%, respectively, according to the solution of the pairwise comparison matrix of the SWOT main criteria (Table 13). CR was calculated as 0.06. This result shows that the matrix is consistent and that the strong aspects of the land management and cadastre system in Turkey (37%) and the opportunities for outsourcing (36%) are more dominant than the other factors.

The local weights of the factors that constitute the sub-criteria of strengths were calculated as 36% for the fact that the only institution in charge of the land registry and cadastre activities, 17% for deep rooted institutional experience, 15% for widespread organizational structure, 13% for strong corporate budget, 8% for institutional level TSE ISO EN 9001-2008 Quality Certificate, 6% for the possibility of undertaking land registry and cadastre operations abroad, and 6% for offering consultancy for other countries based on professional and technical knowledge. CR was calculated as 0.07 (see Appendix B, Tables B1). According to these results, the strongest aspect of the land administration and cadastre system in Turkey in terms of institution is the responsibility of the sole agency of land registry and cadastre activities.

The local weights of the factors that constitute the sub-criteria of the weaknesses were calculated as 31% for inadequacies in control and supervision", 18% for inefficiencies in vocational training, 16% for the lack of qualified and specialized personnel, 13% for the number of personnel not increasing in line with the increased volume of transactions, 10% for the institutional law and its structure not meeting institutional needs, 7% for the lack of an effective human resources policy, and 5% for the lack of personnel trained in international land administration law. CR was calculated as 0.07 (see Appendix B, Tables B2). According to this result, the weakest point of the land administration and cadastral system in Turkey is insufficient control and supervision.

The local weights of the factors that constitute the sub-criteria of the opportunities that arise in relation to the external environment were calculated as 32% for the development of cooperation with non-governmental organizations, and the public and private sector, 23% for trained human resources, 17% for the development of e-government automation projects, 9% for directions in the European Union (EU) harmonization process, 9% for the possibility of using more external financing originated loans, 7% for international standardization activities such as ISO and OGC and 3% for the dissemination of a management information system using a database. The consistency rate was calculated as 0.08 (see Appendix B, Tables B3). According to these results, the development of cooperation with non-governmental organizations, and the public and private sector was the most important opportunity that emerged in relation to the external environment for land administration and cadastre system in Turkey.

The local weights of the factors that constitute the sub-criteria of the threats arising from the external environment were calculated as 36% for partially participate in cadastral activities of different institutions other than the GDLRC, 26% for GDLRC not having a sufficient share from general budget, 11% for the lack of a sustainable national land management policy, 10% for weak cooperation between institutions and data sharing on global and national level, 8% for the lack of an effective national land management policy 5% for slowing down EU harmonization process and 5% for political and economic instability in the region and the world. The consistency rate was calculated as 0.05 (see Appendix B, Tables B4). According to this result, the partial participation in cadastral activities of different institutions apart from the GDLRC is the most important threat to the cadastral system and land administration in Turkey due to the external environment.

6.3. Technical aspects

The pairwise comparison of the main and sub-criteria of the SWOT analysis group pertaining to the technical aspects is given in Appendix C, Tables C1–C4. The weights obtained from the model solution are shown in detail in Table 14 for both the main and sub-criteria. The local weights in Table 14 are the values found in the result of the pairwise comparison for each factor. The general weights are the share of the SWOT group factors in the total weight. The strengths, weaknesses, opportunities and threats are weighted by 37%, 15%, 36% and 12%, respectively, according to the solution of the SWOT main criteria pairwise comparison matrix (Table 14). The consistency rate was calculated as 0.06. These results indicate that the matrix is consistent and that in Turkey the strengths s of the land management and cadastre system (37%) and the opportunities for outsourcing (36%) are more dominant than the other factors.

The local weights of the factors that constitute the sub-criteria of strengths were calculated as 25% for completion of TAKBIS, MEGSIS, TUCBS, HBB, TUSAGA-ACTIVE projects, 16% for data sharing online and offline, 15% for continuous project development for innovation, research and development purposes, 14% for the transition to online appointment system at all directorates, 13% for the completion of transition to TAKBIS throughout Turkey, 9% for access to information on land parcels through e-government and 8% for having a strong archive structure. As shown in Appendix C, Table C1 the consistency rate is calculated as 0.08. According to this result, the completion of civil society organizations, TAKBIS, MEGSIS, TUCBS, HBB, TUSAGA-ACTIVE projects is the most important opportunity for the land administration and cadastre system in Turkey due to the external environment.

The local weights of the factors that constitute the sub-criteria of the weaknesses respectively were calculated as 29% for the use of different measurement, base and coordinate systems, 23% for mistakes arising from measurements, limitations, plotting and calculations, 17% for not transferring the land registry and cadastre information to a totally digital medium due to the shortcomings of the transition process of the graph information, 12% for the continuation of parcel-based cadastre, 9% for 2D cadastral measurement and recording not being 100% completed, 6% for the failure to complete the transition to an object-oriented database and inadequate infrastructure and 4% for problems in the detection, restraint, and appropriation of summer pasture, leas, winter quarters and the places where the forest has lost its distinctive characteristics. The consistency rate was calculated as 0.07 (see Appendix C, Tables C2). According to this result, the weakest aspect of the land management and cadastral system in Turkey is the use of different measurement, base and coordinate systems".

The local weights of the factors that constitute the sub-criteria of the opportunities that arise in relation to the external environment were calculated as 24% for technological developments related to 3D data acquisition and display, 22% for the increasing need for spatial information management system, 18% for developing measurement techniques in terms of technically and technologically, 15% for the development of satellite and mobile technologies and the ability to collect spatial data regardless of distance, 13% for data management and data security with relational database, 5% for the power of the private sector and 3% for widespread inter-sectoral relations with

information and communication technology. The consistency rate was calculated as 0.09 (see Appendix C, Tables C3). According to this result, at present 3D data collection and technological developments are the most important opportunities for the land management and cadastre system in Turkey due to the external environment.

The local weights of the factors that constitute the sub-criteria of the threats arising from the external environment were calculated as 29% for the disappearance of natural boundaries because of disasters, 27% for the prohibition of a second cadastre, 16% for the high cost of three-dimensional data collection, 11% for the risks in data sharing in the digital environment, 8% for the need for outsourced software related to software management, 5% for vertical expansion in urban areas and 4% for difficulties in data provision from different institutions. CR was calculated as 0.06 (see Appendix C, Tables C4). According to these results, in terms of the external environment, the disappearance of natural borders after disasters was the most important threat in the technical aspect for the land administration and cadastre system in Turkey.

7. Conclusion and recommendations

This study presents a general framework of the current land management and cadastral system in Turkey based on the main components determined in the Cadastre 2034 vision. SWOT analysis and AHP method integration were used to obtain the statistical significance of these generated frameworks. In this context, Turkey, which has a deeply rooted institutional structure and experience in terms of land administration and cadastre, needs to be able to take part in developing (or globalizing) land administration and the cadastral structure. Therefore, in order to make improvements in the field of land development and cadastre it was analyzed the existing structure from the LIT aspects to determine the most appropriate strategy for the vision of Cadastre 2034. The summary of the analysis is given in the following sections.

7.1. Legal aspect

When the sub-criteria constituting the legal analysis are evaluated within their group, the strongest point of the existing land management and cadastral system in Turkey is determined to be the legal guarantee of the property right. For the weakest aspect of the existing land management and cadastre system in Turkey, the prohibition of a second cadastre comes into prominence. The existence of a land administration domain model emerges as the most outsourced opportunity for the existing land management and cadastre system in Turkey. The most important threat to the existing land management and cadastre system in Turkey is the risk of the existence of different laws limiting land management and cadastral activities.

It was developed four different strategies according to the SWOT main and sub-criteria and their priorities (see Table 6). These are providing enterprise-level participation in the work of international standardization, improving the legal infrastructure for the acceleration of the decision-making process for property cases, training of lawyers specialized in the field of land management and cadastre, and updating the land administration legislation according to the conditions of the day.

According to the results obtained by applying Eq. (19), the most important strategy to be implemented in the land management and cadastre system in Turkey is to update the land administration legislation according to present day conditions (30%) and the second is the participation in international standardization studies at the institutional level (28%). The third priority strategy is the improvement of the legal infrastructure to accelerate the decision-making process for property cases (27%) and the fourth is to train specialist lawyers in land administration and cadastre (15%).

7.2. Institutional aspect

When the sub-criteria related to the institutional perspective are evaluated within their group, the strongest point of the existing land management and cadastral system in Turkey is that the title and cadastral activities are the responsibility of a single institution. The weaknesses of the existing land management and cadastre system in Turkey are considered to be inefficiencies in control and supervision. The development of cooperation with non-governmental organizations, the public and private sectors have been identified as the most outsourced opportunity for the existing land management and cadastre system in Turkey. The most important factor threatening the existing land management and cadastre system in Turkey is the risk that institutions other than GDLRC are partly cadastralized.

Four different strategies have been developed by considering the SWOT main and sub-criteria in terms of institutions and according to their priorities (see Table 9). These are providing a consultancy service according to institutional experience, supporting projects for service provision via e-government, the development of cooperation with public and private sector in line with institutional needs, and the promotion of vocational training to produce a cohort of qualified personnel. According to the results obtained from Eq. (19), the highest priority strategy to be implemented in the land management and cadastre system in Turkey is to disseminate in-service training for qualified personnel (28%), the second priority strategy is to develop cooperation with the public and private sector in line with institutional needs (26%), the third priority strategy is to provide a consultancy service based on institutional experience (25%), and the fourth is to support projects for service provision through e-government (21%).

7.3. Technical aspect

When the sub-criteria that constitute the technical analysis are evaluated within their group, the strongest aspect of the existing land management and cadastre system in Turkey is assessed as the completion of TAKBIS, MEGSIS, TUCBS, HBB, and TUSAGA-ACTIF projects. The weakest aspect of the existing land management and cadastre system in Turkey is the use of different measurement, base, and coordinate systems. Currently, 3D data collection and technological developments are emerging as the most outsourced opportunity for the existing land management and cadastre system in Turkey. The most important factor threatening the existing land management and cadastre system is the risk of disappearing natural borders after disasters.

Four different strategies have been developed from the SWOT main and sub-criteria in terms of technical aspects and according to their priorities (see Table 11). These strategies are; developing the necessary infrastructure for the online delivery of corporate services, the legal possibility of creating a second cadastre, completion of the country cadaster and acceleration of the transition to object-based cadastre, and the use of technical and technological measurement techniques in the spatial data collection. According to the results obtained by applying Eq. (19), the most important strategy that should be applied in terms of the land management and cadastre system in Turkey is to use technical and technological measurement techniques in the spatial data collection (38%), the second priority strategy is to develop the necessary infrastructure for the online delivery of corporate services (35%), the third is to complete the country cadastre and accelerate the transition to object-based cadastre (18%), and the fourth is to make a second cadastre legally possible (9%).

This study presented the SWOT-AHP methodology to assess the importance of external, internal, negative, and positive outlooks related to the land management and cadastre system in Turkey. The strengths and weaknesses of the existing system and the opportunities and threats encountered in relation to the external environment were evaluated and it is proposed that this new approach is adopted by decision makers in order to realize the principles of the Cadastre 2034 vision. The advantage of this SWOT-AHP method discussed in this paper is that it can offer a more comprehensive and effective decision-making process in strategic planning than the traditional SWOT analysis.

Appendix A. Comparison matrixs of strengths, weaknesses, opportunities and threats related to the legal aspect

Table A1
Comparison matrix of strengths related to the legal aspect.

Strengths (S)	S_1	S_2	S_3	S_4	S_5	S_6	S_7	Local priorities
S_1	1.00	0.20	0.33	1.00	0.33	0.33	0.20	0.05
S_2	5.00	1.00	3.00	3.00	3.00	5.00	0.33	0.24
S_3	3.00	0.33	1.00	3.00	1.00	3.00	0.33	0.13
S_4	1.00	0.33	0.33	1.00	0.50	2.00	0.20	0.06
S_5	3.00	0.33	1.00	2.00	1.00	2.00	0.33	0.11
S_6	3.00	0.20	0.33	0.50	0.50	1.00	0.20	0.06
S_7	5.00	3.00	3.00	5.00	3.00	5.00	1.00	0.35
CR = 0.05								

Table A2
Comparison matrix of weaknesses related to the legal aspect.

Weaknesses (W) (W)	W_1	W_2	W_3	W_4	W_5	W_6	W_7	Local priorities
W_1	1.00	0.33	3.00	0.33	0.50	3.00	3.00	0.13
W_2	3.00	1.00	3.00	1.00	1.00	3.00	3.00	0.21
W_3	0.33	0.33	1.00	0.33	0.33	0.50	1.00	0.06
W_4	3.00	1.00	3.00	1.00	0.33	5.00	3.00	0.20
W_5	2.00	1.00	3.00	3.00	1.00	3.00	4.00	0.26
W_6	0.33	0.33	2.00	0.20	0.33	1.00	0.33	0.06
W_7	0.33	0.33	1.00	0.33	0.25	3.00	1.00	0.07
CR = 0.07								

Table A3
Comparison matrix of opportunities related to the legal aspect

Opportunities (O)	O_1	O_2	O_3	O_4	O_5	O_6	O_7	Local priorities
O_1	1.00	3.00	2.00	1.00	3.00	1.00	0.33	0.18
O_2	0.33	1.00	0.50	0.33	0.33	0.25	0.50	0.05
O_3	0.50	2.00	1.00	1.00	2.00	0.50	1.00	0.13
O_4	1.00	3.00	1.00	1.00	3.00	1.00	2.00	0.19
O_5	0.33	3.00	0.50	0.33	1.00	0.33	1.00	0.09
O_6	1.00	4.00	2.00	1.00	3.00	1.00	3.00	0.23
O_7	3.00	2.00	1.00	0.50	1.00	0.33	1.00	0.15
CR = 0.07								

Table A4
Comparison matrix of threats related to the legal aspect.

Threats (T)	T_1	T_2	T_3	T_4	T_5	T_6	T_7	Local priorities
T_1	1.00	0.50	5.00	3.00	1.00	0.33	0.33	0.11
T_2	2.00	1.00	5.00	3.00	3.00	0.33	0.25	0.16
T_3	0.20	0.20	1.00	1.00	0.25	0.20	0.20	0.04
T_4	0.33	0.33	1.00	1.00	0.33	0.33	0.25	0.05
T_5	1.00	0.33	4.00	3.00	1.00	1.00	0.25	0.11
T_6	3.00	3.00	5.00	3.00	1.00	1.00	0.33	0.19
T_7	3.00	4.00	5.00	4.00	4.00	3.00	1.00	0.34
CR = 0.08								

Appendix B. Comparison matrixs of strengths, weaknesses, opportunities and threats related to the institutional aspect

Table B1
Comparison matrix of strengths related to the institutional aspect.

Strengths (S)	S_1	S_2	S_3	S_4	S_5	S_6	S_7	Local priorities
S_1	1.00	5.00	5.00	3.00	3.00	3.00	5.00	0.33
S_2	0.20	1.00	0.33	1.00	3.00	3.00	3.00	0.11
S_3	0.20	3.00	1.00	1.00	3.00	3.00	4.00	0.15
S_4	0.33	1.00	1.00	1.00	3.00	3.00	3.00	0.13
S_5	0.33	0.33	0.33	0.33	1.00	2.00	2.00	0.06
S_6	0.33	0.33	0.33	0.33	0.50	1.00	2.00	0.05
S_7	0.20	0.33	0.25	0.33	0.50	0.50	1.00	0.04
CR = 0.07								

Table B2
Comparison matrix of weaknesses related to the institutional aspect.

Weaknesses (W)	W_1	W_2	W_3	W_4	W_5	W_6	W_7	Local priorities
W_1	1.00	2.00	3.00	3.00	3.00	3.00	6.00	0.31
W_2	0.50	1.00	1.00	1.00	3.00	3.00	3.00	0.16
W_3	0.33	1.00	1.00	2.00	3.00	4.00	3.00	0.18
W_4	0.33	1.00	0.50	1.00	2.00	3.00	3.00	0.13
W_5	0.33	0.33	0.33	0.50	1.00	0.33	3.00	0.07
W_6	0.33	0.33	0.25	0.33	3.00	1.00	4.00	0.10
W_7	0.17	0.33	0.33	0.33	0.33	0.25	1.00	0.04
CR = 0.07								

Table B3
Comparison matrix of opportunities related to the institutional aspect.

Opportunities (O)	O_1	O_2	O_3	O_4	O_5	O_6	O_7	Local priorities
O_1	1.00	2.00	5.00	3.00	3.00	3.00	7.00	0.32
O_2	0.50	1.00	3.00	3.00	2.00	3.00	7.00	0.23
O_3	0.20	0.33	1.00	1.00	2.00	0.25	3.00	0.09
O_4	0.33	0.33	1.00	1.00	0.33	0.25	2.00	0.07
O_5	0.33	0.50	0.50	3.00	1.00	0.33	2.00	0.09
O_6	0.33	0.33	4.00	4.00	3.00	1.00	2.00	0.17
O_7	0.14	0.14	0.33	0.50	0.50	0.50	1.00	0.04
CR = 0.08								

Table B4
Comparison matrix of threats related to the institutional aspect.

Threats (T)	T_1	T_2	T_3	T_4	T_5	T_6	T_7	Local priorities
T_1	1.00	3.00	5.00	5.00	5.00	3.00	5.00	0.36
T_2	0.33	1.00	0.33	2.00	3.00	0.25	2.00	0.10
T_3	0.20	0.20	1.00	3.00	3.00	0.25	1.00	0.08
T_4	0.20	0.50	0.33	1.00	2.00	0.20	0.25	0.05
T_5	0.20	0.33	0.33	0.50	1.00	0.25	0.20	0.04
T_6	0.33	4.00	4.00	5.00	4.00	1.00	4.00	0.26
T_7	0.20	0.50	1.00	4.00	5.00	0.25	1.00	0.11
CR = 0.05								

Appendix C. Comparison matrixs of strengths, weaknesses, opportunities and threats related to the technical aspect

Table C1
Comparison matrix of strengths related to the technical aspect.

Strengths (S)	S_1	S_2	S_3	S_4	S_5	S_6	S_7	Local priorities
S_1	1.00	2.00	3.00	3.00	1.00	2.00	3.00	0.25
S_2	0.50	1.00	2.00	2.00	0.50	1.00	1.00	0.13
S_3	0.33	0.50	1.00	1.00	0.33	0.50	1.00	0.08
S_4	0.33	0.50	1.00	1.00	1.00	0.50	1.00	0.09
S_5	1.00	2.00	3.00	1.00	1.00	0.50	0.33	0.15
S_6	0.50	1.00	2.00	2.00	2.00	1.00	0.50	0.14
S_7	0.33	1.00	1.00	1.00	3.00	2.00	1.00	0.16
CR = 0.08								

Table C2
Comparison matrix of weaknesses related to the technical aspect.

Weaknesses (W)	W_1	W_2	W_3	W_4	W_5	W_6	W_7	Local priorities
W_1	1.00	2.00	3.00	3.00	3.00	4.00	5.00	0.29
W_2	0.50	1.00	3.00	2.00	3.00	4.00	6.00	0.23
W_3	0.33	0.33	1.00	3.00	3.00	3.00	5.00	0.17
W_4	0.33	0.50	0.33	1.00	0.33	3.00	3.00	0.09
W_5	0.33	0.33	0.33	3.00	1.00	3.00	4.00	0.12
W_6	0.25	0.25	0.33	0.33	0.33	1.00	2.00	0.05
W_7	0.20	0.17	0.20	0.33	0.25	0.50	1.00	0.03
CR = 0.07								

Table C3
Comparison matrix of opportunities related to the technical aspect.

Opportunities (O)	O_1	O_2	O_3	O_4	O_5	O_6	O_7	Local priorities
O_1	1.00	3.00	1.00	0.33	3.00	1.00	5.00	0.18
O_2	0.33	1.00	3.00	2.00	4.00	1.00	6.00	0.22
O_3	1.00	0.33	1.00	1.00	3.00	1.00	6.00	0.15
O_4	3.00	0.50	1.00	1.00	4.00	3.00	6.00	0.24
O_5	0.33	0.25	0.33	0.25	1.00	0.25	2.00	0.05
O_6	1.00	1.00	1.00	0.33	4.00	1.00	3.00	0.13
O_7	0.20	0.17	0.17	0.17	0.50	0.33	1.00	0.03
CR = 0.09								

Table C4
Comparison matrix of threats related to the technical aspect.

Threats (T)	T_1	T_2	T_3	T_4	T_5	T_6	T_7	Local priorities
T_1	1.00	0.20	0.17	0.50	0.20	0.33	0.33	0.04
T_2	5.00	1.00	1.00	5.00	3.00	3.00	5.00	0.29
T_3	6.00	1.00	1.00	5.00	3.00	3.00	3.00	0.27
T_4	2.00	0.20	0.20	1.00	0.25	0.25	0.33	0.05
T_5	5.00	0.33	0.33	4.00	1.00	3.00	2.00	0.16
T_6	3.00	0.25	0.33	4.00	0.33	1.00	0.33	0.09
T_7	3.00	0.20	0.33	3.00	0.50	3.00	1.00	0.11
CR = 0.06								

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