“Smart sustainability ranking system within local budgeting”

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SMART SUSTAINABILITY RANKING SYSTEM WITHIN LOCAL BUDGETING

Abstract

The study focuses on the need to update tools for making local governance decisions using modern information technology in an environment of unpredictability added by the pandemic. Policy formulation by the authorities, especially local governments, is faced with the demand for sustainable development due to the obstacles and risks that have arisen. The purpose of the paper was to create a model for an intelligent information system to rank input qualitative information as an object in accordance with sustainability criteria for determining the local government's policy on budgetary support for entrepreneurial activity. Fuzzy informatics methods used in soft computing based on fuzzy logic improve estimation potential.

The activity in community-based tourism (CBT) was chosen as a basis for simulating the "Intelligent Ranking System" for local budgeting. In the paper, the system ranks four factors of sustainability according to the importance of local government activity by nine criteria, whose fuzzy values are calculated based on expert judgments within the framework of six linguistic variations. Simulation of future directions of budgeting was developed using unified answers from the example of India for applying in local tourism. The basis of the system matrix is formed through the subsequent analysis of deviations from the limiting variations of the maximum positive and maximum negative impressions of experts. The model of this ranking system will be useful for service-oriented activities where consumer impressions are an important development requirement.

Keywords public budgeting, local governance, fuzzy logic, community based tourism, ranking intelligent system

JEL Classification C60, H11, H61, R51

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РОЗУМНА СИСТЕМА РЕЙТИНГУВАННЯ СТІЙКОСТІ ПРИ МІСЦЕВОМУ БЮДЖЕТУВАННІ

Анотація

Дослідження фокусується на необхідності модернізації інструментів для прийняття рішень органами місцевого самоврядування з використанням сучасних інформаційних технологій в умовах непередбачуваності, доданої пандемією. При розробці політики владою, особливо місцевими органами влади, посилюється необхідність у сталому розвитку через виклики перешкод і ризиків. Метою публікації є створення моделі для розрахунку інформаційної системи для ранжування ввідної якісної інформації як об'єкта за критеріями стійкості для визначення політики влади з бюджетної підтримки підприємницької діяльності. Використані методи нечітких методів інформатики в рамках обчислень на основі нечіткої логіки покращують потенціал оцінки.

Діяльність у сфері місцевого туризму була обрана як основа моделювання «Інтелектуальної системи рейтингу» для місцевого бюджетування. У статті системою класифіковано чотири фактори стійкості відповідно до важливості дев'яти критеріїв діяльності місцевого самоврядування, нечіткі значення яких обчислюються на основі експертних суджень в рамках шести лінгвістичних варіацій. На прикладі Індії для місцевого туризму було розроблено моделювання подальших напрямків бюджетування на основі уніфікованих відповідей. Основа матриці сформована через подальший аналіз відхилень від граничних варіацій максимально позитивного та максимально негативного експертного оцінювання. Модель цієї рейтингової системи буде корисною для діяльності, орієнтованої на послуги, важливою умовою для розвитку якої є оцінки споживачів.

Ключові слова державне бюджетування, місцеве самоврядування, нечітка логіка, туризм орієнтований на громаду, розумна система рейтингування

Класифікація JEL C60, H11, H61, R51

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INTRODUCTION

The sustainable public policy implementation was intensified among public budgeting tasks at the local level during the COVID-19 pandemic. The basic benchmarks of best budgetary funds redistributing in its limitation conditions because of risks (pandemic etc.) require the most modern methods and tools of applying public budgeting decisions at the local governance level. Local governance authorities are searching for the ways of combining familiar services and policy (Innes and Booher, 2010) with new criteria for the sustainable development in lockdowns bonding.

In developing countries, particularly in India, the uncertain conditions of the local budget revenues and expenditures raise the need to look for sustainability creation to balance follow-up. In large and crowded regions where people's activities are diversified, tourism industry indeed could provide many benefits to the communities that lack the knowledge and financial resources. Local tourism for community could reduce the negative impacts of new circumstances.

Therefore, local governance authority could develop regional businesses to provide budget revenue and improve the psychological state of the population at the time of shutdown by redistributing budget support within the target public budgeting on the community-based tourism (CBT) development example. As for the previous experience of the leading countries in efficient budgeting, EU residents spent 82% of their tourism expenditure on trips inside Europe (78% inside the EU) according to the Eurostat data. In this paper we propose to join the rhetoric about the indicators and its weak directions assessment to support local governors with the real decisions in budgeting concerning the problems which can be solved by qualitative estimation feedback applying soft computing tools.

The regions in developing countries are getting involved into the struggle against pandemic crisis without any external support. The general concept of sustainability is based on the ability to meet social needs with the available resources (Shrivastava and Berger, 2010). When access to resources or the necessities changes, sustainability changes its criteria. New sustainability development principles are introduced to encourage and empower the communities. Soft computing methods allow calculating data based on the current impact evaluation in the changing environment in addition to hard-calculated quantitative indicators. With the purpose of determining directions to budget resource allocation for the local authorities during the policy implementation in the unfamiliar conditions, the design of an Intelligent Sustainability Ranking System simulation is proposed. It is based on four pillar factors such as Economic Sustainability (ES), Social Sustainability (SS), Environmental Sustainability (ENS), and Cultural Sustainability (CS).

1. LITERATURE REVIEW

Budgeting, for now, is provided under constraints of financial resource, with the impact of environmental and pandemic risks for public budgets. Khan (2019) points out the necessity for a government or local authority to "carefully evaluate its allocation decisions" (p. 8). Since budgeting deals with the allocation of the budget revenues by the local governors, the researchers should provide the decision-makers with set of tools and techniques that are useful for the further budget support inner evaluating. Chohan and Jacobs (2018) pointed out that sometimes the government uses the term "sustainability" without actually taking politically costly budget decisions (p. 1225). Sustainable tourism is one of the most important topics in the global tourism industry nowadays (Giampiccoli et al, 2020). CBT gives the possibility for the local community authorities to be involved in the local business support outcome. With the steady employment and taxation that means fiscal sustainability, budget deficits and public debt are smaller (Fuentes-Silva, 2020). The main product of tourism is the tourist's impressions who pay and create revenues for further taxes payment. Open Data for the budgeting, public budget support requirement along with the sustainability indicators ranking for the regional tourists and tourism workers create the ground for prompt local government reaction and activity correction during real-time evaluation of the tourist's impressions. In the current economic situation considering the regional policy implementation, the CBT is a way of developing social, economic, environmental, cultural requirements of local communities as pointed by Han at al. (2019).

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In India it has been seen that the tourism industry can provide many benefits to the communities that lack the knowledge and financial resources to get involved in the development of tourism without any external support. Promotion "Vocal for Local" motto of the Prime minister of India in 2020 is described by Srivastava (2020).

"The beneficial effects of technical achievements in budgeting could have been weakened by the temptations to manipulate financial information for short-term political advantage" as pointed by Heald and Hodges (2020, p. 4), and openness of data evaluating could help to prevent it. The authority's explanation of local governance sustainability for the community is a key factor in policymaking and strategic management as it promotes the local's activities growth in the region. The local budgeting could rely on managerial accountability and multi-sector assessment of certain criteria. Sustainable activity is a steadily growing process in the tourism industry. Lee and Farzipoor (2012) proposed to measure complex busines's sustainability management by introducing DEA technique. Their proposed model considers dual-role factors in across-efficiency context with the three result variations. Butnariu and Avasilcai (2015, p. 1234) pointed that "sustainability reports are formed to transform the sustainability aspects in quantifiable values of economic, environmental and social performance, with the main purpose to help to manage the key preoccupation for sustainability and to provide information on the way in which the activity contributes to sustainable development". The model proposed by the authors specifies the number of indicators by aggregation in a composite index. Beekaroo et al. (2019, p. 257) determined and unified the sustainability indicators' scores for the different types of activity. "The key dimensions for the assessment of sustainability were identified using the survey method and interview of opinion experts". The last sustainability index model differs from previous evaluation methods by providing an idea of the comparison platform for estimation participants. The composite resulting index, proposed by the authors too, combines economic, social, and environmental indicators in an indexing algorithm useful to rank even different spheres according to their performance. These approaches to defining sustainable activity formed the basis for the selection of two borders of sustainability indicators assessment in this study.

According to Verawati (2020), today internal evaluation and accountability are important issues in the implementation of the public budget as a motivational tool and an instrument for creating public space. Previously Srivastava and Srivastav (2020, p. 791) suggested a soft computing-based tourist's destination recommendation system for a particular region in India. The calculation was "based on Soft Computing tools with a sensitivity analysis approach to develop the ranks under the features of uncertainties to provide an appropriate platform for the convenience of experts under the Soft Computing knowledge domain".

2. AIMS

Create a model for calculating an information system for ranking input qualitative information regarding sustainability criteria to determine government policy for budgeting support of the entrepreneurial activity, while continuing to improve the assessment potential using fuzzy computer science methods within soft computing based on the fuzzy logics.

3. DATA AND METHODOLOGY

The entity's operations segregation and measurement combination are common to all previous estimations of sustainability in the literature review. These publications used a basic multidimensional approach to assess qualitative results in terms of economic, as well as social and environmental indicators of the region's development. Reviewed research elucidates the role of various aspects of sustainability, such as economic, social, cultural and environmental, in stimulating private activity.

To encourage and empower the communities' modern sustainability, development principles could be introduced by publishing the inner assessment indicators of future budgeting and policies. The local community activities involvement and self-sufficiency in tourism is one of the main features that have been reflected in the CBT development. The soft computing techniques based on fuzzy logic, in particular, fuzzy methods, allows creating a system to interpret tourist's (expert's) reactions to sustainability indicators changing. These changes could be prevented or managed from the very beginning with calculation and estimation of input data by Fuzzy sets.

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In order to develop the ranking system, we are using Fuzzy sets, which were described by Zadeh (1965) and further developed by Klir and Yuan (2015), and Fuzzy TOPSIS in respect to the publication by Chen (2000). Four key factors of sustainability in the case of CBT were determined and the resulting system was configured by attempts to apply two variations of the comparison.

To measure and rank the people's input suggestions we decided to construct five linguistic terms that will be valued as a variable. In the matrix simulation for this paper the two group expert's answers were combined into two input information sets.

Definitions are as follows:

1. Fuzzy Sets. A fuzzy set $\tilde{A}$ in a universe of discourse R is defined by a membership function $\tilde{\mu}_A(x)$ such that $\tilde{\mu}_A(x) \rightarrow [0,1] \forall x \in R$.
2. Fuzzy Numbers. A fuzzy number is a fuzzy subset in the universe of discourse, *R*. It is both convex and normal. Trapezoidal fuzzy numbers are shown below.
3. Trapezoidal Fuzzy Number. The trapezoidal fuzzy number (TrFN) is presented by $\tilde{A} = (a,b,c,d)$ and its membership function is given by:

$$\tilde{\mu}_A(x) = \begin{cases} \dfrac{x-a}{b-a}, & a \le x \le b \\ 1 & , b \le x \le c \\ \dfrac{d-x}{d-c} & , c \le x \le d \\ 0 & , elsewhere \end{cases} \quad . \qquad (1)$$

4. Normalized Fuzzy Sets. A fuzzy set $\tilde{A}$ of the universe of discourse, R, is said to be normalized fuzzy set if an x ∍ R such that $\tilde{\mu}_A(x) = 1$.
5. Linguistic Variables. A variable whose values are linguistic terms. The linguistic values can also be expressed as fuzzy numbers. These linguistic values mean the state of tourism in the region by people's impressions, their preferences for the results of its development to the current moment and future prospects.

For example, "weight" in the simulation is a linguistic variable; its values are "very low", "moderately important", "important", "very important", "absolutely important" etc.

6. Distance between two trapezoidal fuzzy numbers. Suppose, there are two trapezoidal fuzzy numbers $\tilde{A} = (a_1, a_2, a_3, a_4)$ and $\tilde{B} = (b_1, b_2, b_3, b_4)$ with centroid points (α_A, β_A) and (α_B, β_B); left and right spreads are (L_A, R_A) and (L_B, R_B) respectively. Then the distance between two trapezoidal fuzzy numbers (Ebadi at al., 2013) is given by:

$$d(\tilde{A}, \tilde{B}) = \max\{|\alpha_A - \alpha_B|, |\beta_A - \beta_B|, |L_A - L_B|, R_A - R_B|\}, \qquad (2)$$

where, $\alpha_A = \dfrac{\left[a_1 + a_2 + a_3 + a_4 - \left(\dfrac{a_4 a_3 - a_1 a_2}{(a_4 + a_3) - (a_1 + a_2)}\right)\right]}{3}$; $\beta_A = \dfrac{\left[1 - \dfrac{a_3 - a_2}{(a_4 + a_3) - (a_1 + a_2)}\right]}{3}$

$$L_A = a_2 - a_1,\ R_A = a_4 - a_3.$$

A positive ideal solution and a negative ideal solution mean the key points of the system of opinions and create the variables field. The Fuzzy TOPSIS works on the concept of distance to positive ideal solution and negative ideal solution, the basic procedure of Fuzzy TOPSIS is given by a number of steps as.

Step 1. In order to develop the system, the steps of Fuzzy TOPSIS are given below in Table 1.

Table 1. Fuzzified scale for pairwise comparison

Source: Calculated by the authors.

Linguistic Variables	Fuzzy Scale
Equal Importance (Eq.I)	(1, 1, 1, 1)
Very Less Important (VLI)	(0, 0.5, 1.5, 2)
Less Important (LI)	(1, 1.5, 2.5, 3)
Important (I)	(2, 2.5, 3.5, 4)
Very Important (VI)	(3, 3.5, 4.5, 5)
Extremely Important (EI)	(4, 4.5, 5.5, 6)

Suppose, there are k decision-makers. If the fuzzy rating and weight of importance of kth decision-maker about ith alternative concerning jth criteria are $\tilde{x}_{ij}^{k}=(a_{ij}^{k},b_{ij}^{k},c_{ij}^{k},d_{ij}^{k})$ and $\tilde{w}_{j}^{k}=\left(w_{j1}^{k},w_{j2}^{k},w_{j3}^{k},w_{j4}^{k}\right)$ respectively, where i=1,2,3, …,m and j=1,2,3,…,n.

Step 2. Aggregated fuzzy rating i^{th} alternative concerning j^{th} criteria are given by $\tilde{x}_{ij}=(a_{ij},b_{ij},c_{ij},d_{ij})$ such that:

$$a_{ij}=\min_{k}\{a_{ij}^{k}\},\ \mathrm{b}_{ij}=\min_{k}\{b_{ij}^{k}\},\ \mathrm{c}_{ij}=\min_{k}\{c_{ij}^{k}\},\ \mathrm{d}_{ij}=\min_{k}\{d_{ij}^{k}\}. \quad (3)$$

And the aggregated fuzzy weights of importance are $\tilde{w}_{j}=\left(w_{j1},w_{j2},w_{j3},w_{j4}\right)$, where

$$w_{j1}=\min_{k}\{w_{j1}^{k}\},\ w_{j2}=\min_{k}\{w_{j2}^{k}\},\ w_{j3}=\min_{k}\{w_{j3}^{k}\},\ w_{j4}=\min_{k}\{w_{j4}^{k}\}.$$

Step 3. The fuzzy decision matrix of aggregate values is expressed by the following:

$$\tilde{D}=\begin{matrix} & C_1 & C_2 & \cdots & C_n \\ A_1 & \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ A_2 & \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ A_m & \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{matrix}. \quad (4)$$

And the aggregate fuzzy importance weights are: $\tilde{W}=\left[\tilde{w}_1,\tilde{w}_2,\tilde{w}_3,\cdots,\tilde{w}_n\right]$, where each $\tilde{x}_{ij},\tilde{w}_j$ $\forall$ *i*=1,2,3,…,*m* and *j*=1,2,3,…,*n* are linguistic variables and which can be interpreted by trapezoidal fuzzy numbers $\tilde{x}_{ij}=(a_{ij},b_{ij},c_{ij},d_{ij})$ and $\tilde{w}_j=\left(w_{j1},w_{j2},w_{j3},w_{j4}\right)$.

Step 4. The normalized fuzzy decision matrix is given by:

$\tilde{R}=\left[\tilde{r}_{ij}\right]_{m\times n}$, where *i*=1,2,3, …, *m* and *j*=1,2, 3,…, *n*, (5)

$$\left.\begin{array}{l} \tilde{r}_{ij}=\left(\dfrac{a_{ij}}{c_j^{+}},\dfrac{b_{ij}}{c_j^{+}},\dfrac{c_{ij}}{c_j^{+}},\dfrac{d_{ij}}{c_j^{+}}\right) \\ where,\ c_j^{+}=\max_{i}(d_{ij});\quad (\text{for benefit criteria}) \\ \tilde{r}_{ij}=\left(\dfrac{a_j^{-}}{d_{ij}},\dfrac{a_j^{-}}{c_{ij}},\dfrac{a_j^{-}}{b_{ij}},\dfrac{a_j^{-}}{a_{ij}}\right) \\ where,\ a_j^{-}=\min_{i}(a_{ij});\quad (\text{for cost criteria}) \end{array}\right\}.$$

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In this normalization process, the ranges of normalized fuzzy numbers are located within the interval [0, 1].

Step 5. The weighted normalized fuzzy matrix $\tilde{V}$ can be evaluated by:

$$\tilde{V} = \left[\tilde{v}_{ij} \right] = [\tilde{r}_{ij} \otimes \tilde{w}_j]_{m \times n}, \qquad (6)$$

where i=1,2,3, …, m and j=1,2, 3, n.

Step 6. The fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solutions (FNIS) were defined as given below:

$$\left.\begin{array}{l} A^{+} = \left(\tilde{v}_1^{+}, \tilde{v}_2^{+}, \tilde{v}_3^{+}, \cdots, \tilde{v}_n^{+} \right) \\ v_j^{+} = \max\limits_i \left(v_{ij4} \right), \; i = 1,2,3,...,m \text{ and } j = 1,2,3,...,n \\ A^{-} = \left(\tilde{v}_1^{-}, \tilde{v}_2^{-}, \tilde{v}_3^{-}, \cdots, \tilde{v}_n^{-} \right) \\ v_j^{-} = \min\limits_i \left(v_{ij1} \right), \; i = 1,2,3,...,m \text{ and } j = 1,2,3,...,n \end{array}\right\}. \qquad (7)$$

Step 7. The distances d_i^{+} and d_i^{-} of each weighted alternative from fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solutions (FNIS) can be evaluated by the following equations:

$$\begin{array}{l} d_i^{+} = \sum\limits_{j=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^{+}) \;\; i = 1,2,3,...,m, \\ d_i^{-} = \sum\limits_{j=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^{-}) \;\; i = 1,2,3,...,m, \end{array} \qquad (8)$$

where $d_v(\tilde{v}_{ij}, \tilde{v}_j)$ is the distance between two trapezoidal fuzzy numbers $\tilde{v}_{ij}$, and $\tilde{v}_j$.

Step 8. The distance from fuzzy positive ideal solution (FPIS $\tilde{A}^{+}$) and fuzzy negative ideal solutions (FNIS $\tilde{A}^{-}$) are simultaneously represented by the closeness coefficient Cc_i:

$$Cc_i = \frac{d_i^{-}}{d_i^{-} + d_i^{+}}, \; i = 1,2,3,...,m. \qquad (9)$$

The highest value of closeness coefficient represents the best alternative, and it shows the best alternative is the closest one to the FPIS and the farthest one from FNIS.

Step 9. The alternatives are ranked with the help of the closeness coefficient. The intelligent ranking system could interpret the input answers and provide the evaluation of sustainability indicators rank importance for the tourists to allocate budget funding for preventing the problems or stimulate the additional activity with the most ranked sustainability pillars.

4. RESULTS AND APPLICATION OF FTOPSIS

The simulation of the intelligent ranking system was accomplished. A case study is performed to configure the sustainability factors for community-based tourism to develop further budgeting policy of the local government. Based on the previous research reviews we took four pillar factors which are listed below:

1. A_1 -Economic Sustainability.
2. A_2 -Social Sustainability.
3. A_3 - Environmental Sustainability.
4. A_4 -Cultural Sustainability.

As the first baseline for the system, the experts group's unified opinion was utilized as the input information. The line of the authorities activity evaluation criteria was built by the linguistic impressions among: AB – Attitude and Belief towards CBT, HC – Human Capital Development, CBTM – CBT Management, IN – Innovation, TR – Tourism Resource, TRM – Tourism Resources Management, TAP – Tourism Activities and Products, MDIMSI – Market Demand Identification and Marketing Strategy Development, VT – Values for Tourists. With the next criteria application, the experts are ranked by the previously obtained linguistic variations of each pillar factor.

The experts' ratings for each alternative corresponding to each criterion are shown in Table 2 and Table 3. In Table 2 the D1 indicator means the opinion of the first expert group's unified answers with a verified linguistic evaluation on each criterion.

Table 2. Ratings by First Expert Group Opinion

D1	AB	HC	CBTM	IN	TR	TRM	TAP	MDIMSD	VT
ES	VI	EI	LI	VI	EI	I	VI	I	VI
SS	LI	EI	LI	EI	VI	EI	VI	EI	I
ENS	EI	VLI	I	I	EI	VI	EI	EI	EI
CUL	VLI	LI	VI	VI	I	EI	I	LI	VI

Next in the Table 3, the indicator D2 stands for the second expert group's opinion within the criteria given below.

Table 3. Ratings by Second Expert Group Opinion

D2	AB	HC	CBTM	IN	TR	TRM	TAP	MDIMSD	VT
ES	EI	EI	EI	EI	EI	EI	EI	EI	EI
SS	EI	VI	EI	I	EI	EI	VI	I	VI
ENS	EI	EI	VI	I	EI	EI	VI	LI	I
CUL	EI	VI	EI	I	EI	EI	VI	I	VI

In Table 4 the comparison of the main criteria between each expert group's opinion in linguistic evaluation cross-scale was proposed for consideration.

Table 4. Pairwise comparison table for the main criteria

AB	ES	SS	EnS	CS
ES	(1,1,1,1)	(0,0.5,1.5,2)	(0,0.5,1.5,2)	(0,0.5,1.5,2)
SS	(0,0.5,0.666667,2)	(1,1,1,1)	(0.33333,0.4,0.666667,1)	(0.33333,0.4,0.666667,1)
EnS	(0,0.5,0.666667,2)	(1,1.5,2.5,3)	(1,1,1,1)	(0.33333,0.4,0.666667,1)
CS	(0,0.5,0.666667,2)	(1,1.5,2.5,3)	(1,1.5,2.5,3)	(1,1,1,1)

The result of the fuzzy conversion of linguistic ratings given by experts was the base of calculation. The aggregated decision matrix obtained by step 3 is presented by Table 4.

Normalized fuzzy decision matrix applied for the result is shown in Table 5.

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Table 5. Evaluation of Normalized weights

Alternatives	AB	$\tilde{w}_i = \tilde{r}_i \otimes S^{-1}$	W_i Using ATLAB	$N_i = \frac{W_i}{Sum}$
ES	(0, 0.594604, 1.355403, 1.681793)	(0, 0.091536, 0.297982, 0.5806)	0.2501	0.259763
SS	(0, 0.53183, 0.737788, 1.189207)	(0, 0.081872, 0.1622, 0.410)	0.173	0.179684
EnS	(0, 0.740083, 1.02669, 1.565085)	(0, 0.1139, 0.2257, 0.540355)	0.231	0.239925
CS	(0, 1.029884, 1.42872, 2.059767)	(0, 0, 0.032797, 0.320265)	0.3087	0.320627
SUM (S)	(0, 2.8964, 4.548601, 6.495852)	–	0.9628	–
Componentwise (S^{-1})	(0, 0.345256, 0.219848, 0.153944)	–	–	–
Increasing Order (S^{-1})	(0, 0.153944, 0.219848, 0.345256)	–	–	–

Further, we applied normalization described in Step 4. The normalized fuzzy decision matrix with the alternatives and pillar criteria was shown in Table 6.

Table 6. Normalized weights of each alternative corresponding to each criterion

Alternatives \ Criteria	AB	HC	CBTM	IN	TR	TRM	TAP	MDIMSD	VT
ES	0.25976	0.25	0.25	0.25	0.25	0.25	0.247283	0.261445	0.27758
SS	0.17968	0.25	0.25	0.25	0.25	0.25	0.202826	0.27758	0.208537
EnS	0.23992	0.25	0.25	0.25	0.25	0.25	0.347065	0.208537	0.261445
CS	0.32062	0.25	0.25	0.25	0.25	0.25	0.202826	0.252439	0.252439

The fuzzy weights of all criteria are obtained using the F-AHP method, which is shown in Table 7 given below.

Table 7. Fuzzy weights of each criteria

Criteria	Fuzzy weights
AB	(0.033402, 0.058508, 0.138045, 2.319587)
HC	(0, 0.076074, 0.187918, 3.481953)
CBTM	(0, 0.087107, 0.209953, 3.584952)
IN	(0, 0.07929, 0.202919, 3.3554)
TR	(0, 0.091476, 0.267681, 4.43481)
TRM	(0, 0.080467, 0.221766, 3.661457)
TAP	(0, 0.055233, 0.133518, 3.364852)
MDIMSD	(0, 0.05563, 0.126661, 2.978191)
VT	(0, 0.045939, 0.099535, 2.757431)

Now we will arrange the previously mentioned step 5 where a weighted normalized fuzzy decision matrix was obtained, that is shown in Table 8.

Table 8. Normalized weights of each alternative corresponding to each criterion

AB	HC	CBTM	IN	TR	TRM	TAP	MDMS	VT
0.088028	0.12991	0.134098	0.00818	0.165362	0.136701	0.12477	0.110697	0.102255

Further, we will obtain a fuzzy positive ideal solution (FPIS) and negative ideal solution (FNIS) described in step 6 and shown in Table 9.

Table 9. FPIS and FNIS of each criteria

Criteria	FPIS	FNIS
AB	(2.31,2.31,2.31, 2.31)	(0,0,0,0)
HC	(3.48,3.48,3.48,3.48)	(0,0,0,0)
CBTM	(3.6,3.6,3.6,3.6)	(0,0,0,0)
IN	(3.4,3.4,3.4,3.4)	(0,0,0,0)
TR	(4.4,4.4,4.4,4.4)	(0,0,0,0)
TRM	(3.7,3.7,3.7,3.7)	(0,0,0,0)
TAP	(3.4,3.4,3.4,3.4)	(0,0,0,0)
MDIMSD	(3,3,3,3)	(0,0,0,0)
VT	(2.8,2.8,2.8,2.8)	(0,0,0,0)

In the next step, we evaluated the distances of FPIS and FNIS using the method suggested by Ebadi et al. (2013), and Hamming distance, described by Chakraborty and Guha (2010), between two fuzzy numbers. Distance and closeness coefficient are shown in Table 10 and Table 11 given below.

Table 10. Final output obtained by Fuzzy TOPSIS using Ebadi et al. (2013) method

Factors	Distance from FPIS	Distance from FNIS	Closeness Coefficent	Ranks
ES	28.4829692	28.4829692	0.5	1
SS	28.01418879	27.50143077	0.49538158	2
ENS	28.16952654	26.8696423	0.48819128	3
CUL	27.45174549	25.47650164	0.481340362	4

Table 11 shows the results using the Hamming Distance.

Table 11. Final output obtained by Fuzzy TOPSIS using Hamming Distance

Source: Chakraborty and Guha (2010).

Factors	Distance from FPIS	Distance from FNIS	Closeness Coefficient	Ranks
ES	21.9999	7.9386	0.26516	1
SS	22.2779	7.6606	0.25587	2
ENS	66.27204	7.4745	0.10135	4
CUL	22.84729	7.0913	0.23686	3

The next discussion topic is the difference between the approach results. The first approach creates the intelligent system with the average "meaning" about the opinions, but the second approach shifts the rank in the system to the more radical position when experts' inputs ranks for the additional alternatives were more different. Comparison among the results obtained from Fuzzy TOPSIS are shown in the next Table 12.

Table 12. Fuzzy TOPSIS results of the simulation

Alternatives	Fuzzy TOPSIS (Using Ebadi et al.'s Method)	Fuzzy TOPSIS (Using Hamming Distance Method)
ES	1	1
SS	2	2
ENS	3	4
CUL	4	3

The Culture factor obtains lower rank by the first method because the opinions' ranks were widespread.

Created Intelligent Ranking System simulation are proposed to collect and process the opinions of tourists in the region or future consumers of tourism services from local residents. Local government should plan and redirect public budget funds on the basis of tourists' expectations and impressions to stimulate regional CBT.

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Based on the rating obtained in both cases of calculations, we should conclude that the factors of economic and social sustainability are the most important for tourism. Further decisions of local authorities should be primarily aimed at preserving the population's ability to pay and maintaining social balance, and afterward – at streamlining the environment and cultural traditions.

CONCLUSION

The Intelligent Sustainability Ranking System provides the most likely ranking for the four pillars of sustainability for community-based tourism, where the ability to pay off the authorities and citizens come first and the maintenance of cultural parity come last. Based on the results obtained by the system, the local government should first of all pay attention to economic well-being in order to meet the tourism expectations in the region. Using the ranking of four factors according to certain criteria within at least five people impressions allows creating a picture of fuzzy feedback formation for arranging further local governance policies. Thus, the system ranks more nuances and selects the most important ones, using not quantitative indicators, but human feelings and expectations in the provision of service-oriented activity.

Two methods of calculating the criteria assessment also allow us to reveal the width of the range of opinions on a particularly key factor with a further deepening of its assessment. The direction of further scientific development can be the issue of selecting and combining factors and criteria for assessing and stimulating the following promising activities by local authorities within the framework of budgeting in unpredictable conditions.

As CBT is very important part of the government's new campaign i.e., Vocal for Local in India, therefore, local government authorities can use the rankings of sustainability factors provided by the Intelligent Sustainability Ranking System to promote community-based tourism. Low ranking factors can be improved by the government's local budgeting. This system will act as a referral system of the policy among government authorities, respective tourism-related administrative bodies to make policies for sustainable development of community-based tourism and local budgeting which provides sustainability in uncertain conditions.

AUTHOR CONTRIBUTION

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