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A multiple-criteria approach for the evaluation of comparative indicators of sustainable tourism

Marija Janošik[1*], Gabrijela Popović[1], Svetlana Vukotić[1]

[1] University Business Academy in Novi Sad, Faculty of Applied Management, Economics and Finance, Belgrade, Serbia

Abstract: In this paper, a multiple-criteria approach has been applied to evaluate and rank types of development indicators of sustainable tourism. Groups of indicators whose comparison was presented through evaluation and prioritization are economy, the satisfaction of tourists, social and cultural elements, as well as environmental ones. The types of indicators discussed in the paper are designed to provide guidelines for measuring the degree of compliance. Using Pivot Pairwise Relatives Criteria Importance Assessment (PIPRECIA) method we have defined the evaluation of the mentioned indicators and their importance. The primary goal of the paper is to demonstrate the practical sides of the Multiple-Criteria Decision-Making (MCDM) methods in this sort of analysis while highlighting the most crucial sustainable tourism indicators.

Keywords: multiple-criteria decision-making, PIPRECIA method, analysis, sustainable development tourism
JEL classification: C44, L83, Q01

Višekriterijumski pristup namenjen evaluaciji komparativnih pokazatelja održivog turizma

Sažetak: U ovom radu primenjen je višekriterijumski pristup za evaluaciju i rangiranje tipova indikatora održivog razvoja turizma. Grupe indikatora čije poređenje se predstavilo kroz evaluaciju i prioritizaciju u radu su: indikatori ekonomskog karaktera, zadovoljstva turista, socijalni indikatori, kulturni i indikatori stanja životne sredine. Tipovi indikatora o kojima govorimo koncipirani su tako da obezbeđuju smernice za merenje stepena usaglašenosti. Koristeći *Pivot Pairwise Relatives Criteria Importance Assessment (PIPRECIA)* metodu definisali smo evaluaciju navedenih indikatora i njihov značaj. Osnovni cilj rada je da ukaže na korisnost primene višekriterijumskih metoda odlučivanja (*Multiple-Criteria Decision-Making Methods – MCDM*) u implementaciji ove vrste analize, kao i da ukaže na najznačajnije indikatore održivog turizma.

Ključne reči: višekriterijumsko odlučivanje, PIPRECIA metod, analiza, održivi razvoj turizma
JEL klasifikacija: C44, L83, Q01

* marija.janosik@mef.edu.rs

1. Introduction

The basic components of sustainable development are economic development, meeting the main needs of the customers, and ensuring a sustainable level of the population. Sustainable development involves changing technologies and risk management, connecting the economy and "ecology" in decision-making, and reorientating international relations (Lukinović et al., 2017). It is a process involving current requirements without questioning the requirements of future generations, that will have to find a way to meet its own needs. Sustainable development is a procedure that meets current demands while ensuring the ability of future generations to fulfill their own requirements. It encompasses not only the economic and ecological relationship but also aligns ecological development with social policy on the global level. Its approaches demonstrate the impacts of long-term patterns in sustainable production and consumption (Ožegović et al., 2012).

The progress of sustainable tourism development has been analysed using certain indicators. Defining and using sustainable tourism indicators should be one of the key topics at the early stage such as the planning process. Indicators enable constant and consistent monitoring of changes over time, as well as clarifying goals and, just as importantly, making those goals more specific. Indicators should show the state of the tourism industry (e.g., tourist satisfaction), pressure on the system (e.g. lack of water, level of crime), the impact of tourism (e.g. impact on communities, deforestation), the cope of management (e.g. resolving pollution), effects of management actions (e.g. change in pollution level, number of returning tourists). According to Stojanović (2011) "using such a system of indicators would have to provide warnings when new actions are necessary to prevent harmful impacts and provide a basis for long-term planning and analysis of tourism activities" (p. 223). Indicators of sustainable tourism are widely used in many tourist destinations. Also, some countries and tourist destinations have separate centres for monitoring the impact of tourism (Dražić, 2020).

According to Stojanović (2011, p. 224) and Kostić et al. (2018), a group of specialists suggested a set of comparative indicators to the European Union's Commission to assess and measure the level of sustainability of tourism development.

The indicators used for evaluating tourism can be categorized into five groups:

- The first group, economic indicators, assesses the economic impact of tourism on a particular area;
- The second group, tourist satisfaction indicators measure tourists' satisfaction with the quality of facilities and services, as well as their perception of the attractiveness of the area's resources, environment, and sociocultural features;
- The third group, social indicators evaluate the well-being of the local community in the tourist region or place;
- The fourth group, cultural indicators, assesses the extent to which the local community's cultural identity is preserved by tourists from different cultural backgrounds;
- Lastly, environmental indicators provide a snapshot of the condition of the environment and the impact of tourism on specific media.

Comparative indicators are defined based on the need to integrate economic, environmental, social, cultural, and tourist satisfaction factors. These indicators help evaluate the current state of tourism development in a certain area and the results provide important indications of necessary administrative measures and activities that should be done.

The application of indicators is based on a coding system that determines the threshold values for each indicator, based on which the situation is evaluated as critical, tolerable, and sustainable (Stojanović, 2011, p. 225).

The reason these indicators are referred to as warning indicators is that they signal potential issues. To facilitate understanding, a coding system has been introduced which incorporates three zones:

- The red zone signifies that the situation is critical and that immediate action must be taken to modify and tightly control or even halt the further development of tourism;
- The yellow zone indicates that the situation is tolerable, but future tourism growth could cause significant changes, so preventative measures are recommended;
- The green zone evaluates the current state of tourism development as sustainable due to effective management and appropriate measures and action taken in the past.

The experiences from earlier research have defined precise limit values for some of the indicators, while for others they have not, which suggests the necessity of future work and research in the field.

The need for defining the significance of the considered indicators imposes the application of the Multiple-Criteria Decision-Making (MCDM) methods as an adequate approach. In that way, the tourism workers will know what factors have crucial significance and the greatest influence on achieving sustainable tourism goals.

MCDM approaches have been widely used for selecting site locations for energy generation, logistic public services, and retail facilities by considering a set of alternatives and contradictory criteria (Yap et al., 2019). These methods have also been successfully applied in the tourism sector and hospitality industry for managerial decision-making (Mardani et al., 2015). Several articles have proposed an integrated analysis model for sustainable development that combines social, economic, environmental, and technical factors using hybrid MCDM methods (Singh et al., 2022). For example, some studies have focused on Sustainable Development Goals (D'Adamo & Gastaldi, 2022) while others have evaluated smart cities' characteristics as smart tourism destinations (Đukić et al., 2022a).

Lin (2020) used DEMATEL and VIKOR methods to assess the Sustainable Development Indicators (SDI) related to rural and urban tourism development. Rough DEMATEL and Bayesian BWM were used to estimate the effective relationship of the criteria in sustainable sports tourism (Yang et al., 2020). The hybrid MCDM model based on the fuzzy SWARA and fuzzy MARCOS methods was applied to evaluate the health of tourism sites from a sustainable perspective (Taş & Çakir, 2022). Garabinović et al. (2021) have explored the application of the MCDM methods in the eco and sustainable tourism field. The sustainability of the farm tourism sites was evaluated using FUCOM and WS methods in the fuzzy environment (Ocampo, 2022). Researchers have observed the possibility of applying the MCDM methods to assess hotel sustainability (Wang & Nguyen, 2022). Besides, the MCDM approach based on the AHP and WS PLP method was used to evaluate the projects regarding hotel construction (Popovic et al., 2019).

The proposed comparative indicators of sustainable tourism require extensive research and the collection of the necessary information. The definition of comparative indicators itself arose from the need to integrate environmental, economic, cultural, social, and tourist satisfaction indicators which may have contradictory aspects. To achieve optimal results in sustainable goals in the tourism field, it is necessary to define which of the mentioned indicators are decisive and the most influential. With that goal, through the application of the Pivot Pairwise Relative Criteria Importance Assessment (PIPRECIA) method, we can determine which indicators highly affect sustainable development and its improvement (Stanujkic et al., 2017).

2. Methodology

In contrast to the SWARA method, the PIPRECIA method doesn't require criteria to be ranked based on expected significance prior to the use. Although less commonly used than the SWARA method, PIPRECIA has been applied in various scenarios such as assessing customer satisfaction (Stanujkic et al., 2019), personnel selection based on a novel grey PIPRECIA and grey OCRA methods (Ulutaş et al., 2020), the evaluation of the hotel websites (Stanujkic et al., 2021a), selection of renewable energy sources with the plithogenic PIPRECIA method (Ulutaş & Topal, 2022), green supplier's selection (Puška, 2022), and evaluating renewable energy sources using fuzzy logic (Keleş et al., 2022). During the application of the PIPRECIA method, some respondents have suggested that it would be simpler to always compare the significance of the criteria with the first criterion. To accommodate this feedback, a simplified version of PIPRECIA, called PIPRECIA S, has been developed (Stanujkic et al., 2021b). This simplified method could be utilized in future scientific research.

The process used in this study is based on the one outlined in Stanujkic et al.'s (2017) paper and can be divided into the following steps.

Step 1. The selection of evaluation criteria does not require mandatory pre-sorting.

Step 2. The process of determining the relative importance starts from the second criterion and proceeds as follows:

$$s_j = \begin{Bmatrix} >1 & when & C_j \succ C_{j-1} \\ 1 & when & C_j = C_{j-1} \\ <1 & when & C_j \prec C_{j-1} \end{Bmatrix}. \tag{1}$$

Step 3. The coefficient k_j is defined as follows:

$$k_j = \begin{Bmatrix} 1 & j=1 \\ 2-s_j & j>1 \end{Bmatrix}. \tag{2}$$

Step 4. Detection of the recalculated value as follows: q_j

$$q_j = \begin{Bmatrix} 1 & j=1 \\ \dfrac{q_{j-1}}{k_j} & j>1 \end{Bmatrix}. \tag{3}$$

Step 5. The relative weights of the assessed criteria are determined using the following equation:

$$w_j = \frac{q_j}{\sum_{k=1}^{n} q_k}, \tag{4}$$

where w_j represents the relative weight of the criteria j.

3. Research results

The concept of modern business apostrophizes the importance of sustainability in all segments, including tourism. The proposed comparative indicators of sustainable tourism require extensive research and the collection of the required information. Data complexity is

characterized by the fact that they are divided into different groups: economic, ecological, social, cultural, and tourist satisfaction. Presently, it seems to be a valid method to measure the sustainability of tourism. The practices confirmed that the competent authorities and the economic sector are ready to consistently apply these indicators.

In 2018, the European Environment Agency published a report entitled *Tourism and the Environment*, which is the result of the joint work of the EEA, ETC/ ULS (European Topic Center on Urban Land and Soil Systems), and EIONET/NRC TOUERM (EIONET Expert Group for Tourism and Environment) (Giulietti et al., 2018). The European Union Commission's report provides a catalogue of relative benchmarks that aid in evaluating and measuring the level of sustainable progress in tourism development. This contributes to research regarding the impact of tourism on the environment and facilitates the monitoring of sustainability trends (Stojanović, 2011, 229).

In Table 1 we can see the display of indicators connected with sustainable tourism in the European Union.

Table 1: Overview of indicators – Comparative indicators of sustainable tourism of the European Union

Indicator type		**Indicators**	
Ec $_1$	Economic	*Ec* $_{11}$	Seasonal nature of traffic
		Ec $_{12}$	The ratio of overnight stays and accommodation capacities
		Ec $_{13}$	Coefficient of local magnification
		Ec $_{14}$	Employment of the local population
		Ec $_{15}$	Business innovation
Ts $_2$	Tourist satisfaction	*Ts* $_{21}$	Repeat visits
		Ts $_{22}$	Acquired reputation and credibility
		Ts $_{23}$	Tourism policy
		Ts $_{24}$	The importance of heterogeneity of long-term tourism goals
		Ts $_{25}$	Coefficient of local tourist increase
Cu $_3$	Culture	*Cu* $_{31}$	The ratio of accommodation capacity and the number of the population
		Cu $_{32}$	Intensity of tourism
		Cu $_{33}$	The degree of cultural saturation of the local environment
		Cu $_{34}$	Provision of the necessary infrastructure
		Cu $_{35}$	The burden on the budget of local communities
So $_4$	Social	*So* $_{41}$	Participation in tourism in the local net social product
		So $_{42}$	Independence of the local tourism industry
		So $_{43}$	Indicator of the usefulness of tourism for the local community
		So $_{44}$	The influence of international tour operators
Ei $_5$	Environmental indicators	*Ei* $_{51}$	Changes in land use
		Ei $_{52}$	Amount of solid waste per tourist
		Ei $_{53}$	Tourist arrivals by type of transport
		Ei $_{54}$	Controlling the pressure of excessive tourist construction
		Ei $_{55}$	Rational use of natural resources - energy and water

Source: Adapted from Stojanović, 2011, p. 229

The PIPRECIA method was applied to determine which group of indicators, as well as which indicators individually, require special attention and point to aspects that have a key impact on achieving business sustainability. A decision-maker is involved in the decision-making process to assess the listed indicators and determine if the suggested approach is suitable (Đukić et al., 2022b). First step is to determine the importance of groups of indicators and the second step is to assess indicators individually. For this purpose, formulas (1)-(4) will be applied. Table 2 shows the obtained results.

Table 2: The relative importance of indicators group

Indicators	s_j	k_j	q_j	w_j
Ec_1		1	1	0.157
Ts_2	1.30	0.70	1.43	0.224
Cu_3	1.00 am	1.00 am	1.43	0.224
So_4	0.80	1.20	1.19	0.187
Ei_5	1.10	0.90	1.32	0.208
			6.37	1.00 am

Source: Authors' research

The obtained results indicate that the group of indicators Ts_2 - Tourist satisfaction, as well as Cu_3 - Cultural indicators, has the greatest importance, while group Ei_1 - Economic indicators have the least importance in this case.

Based on Table 1, we could notice that each group of indicators includes several indicators, the importance of which will be determined and shown in Tables 3-7.

Table 3 contains the weights of economic indicators.

Table 3: The relative importance of economic indicators

Indicators	s_j	k_j	q_j	w_j
Ec_{11}		1	1	0.230
Ec_{12}	0.90	1.10	0.91	0.209
Ec_{13}	0.70	1.30	0.70	0.161
Ec_{14}	1.20	0.80	0.87	0.201
Ec_{15}	1.00	1.00	0.87	0.201
			4.36	1.00

Source: Authors' research

Based on the economic type of indicators, we can notice that indicator Ec_{11} - Seasonal nature of traffic was singled out as the most significant, while indicator Ec_{13} - Coefficient of local magnification is the least significant.

Table 4 shows the importance of indicators related to tourist satisfaction.

Table 4: The relative importance of tourist satisfaction

Indicators	s_j	k_j	q_j	w_j
Ts_{21}		1	1	0.216
Ts_{22}	1.10	0.90	1.11	0.240
Ts_{23}	0.80	1.20	0.93	0.200
Ts_{24}	1.00	1.00	0.93	0.200
Ts_{25}	0.60	1.40	0.66	0.143
			4.62	1.00

Source: Authors' research

Based on the indicators related to tourist satisfaction, we can note that the most significant indicator is Ts_{22} - Acquired reputation and credibility, while the least important is Ts_{25} - Coefficient of local tourism increase.

Table 5 shows the importance of the considered culture-related indicators according to the decision-maker.

Table 5: The relative importance of cultural indicators

Indicators	s_j	k_j	q_j	w_j
Cu_{31}		1	1	0.206
Cu_{32}	1.00	1.00	1.00	0.206
Cu_{33}	0.70	1.30	0.77	0.159
Cu_{34}	1.10	0.90	0.85	0.176
Cu_{35}	1.30	0.70	1.22	0.252
			4.84	1.00

Source: Authors' research

Indicator Cu_{35} - Burden on the budget of local communities was singled out as the most significant indicator, and Cu_{33} - Degree of cultural saturation of the local environment was singled out as the least important indicator. The importance of social indicators is shown in Table 6.

Table 6: The relative importance of social indicators

Indicators	s_j	k_j	q_j	w_j
So_{41}		1	1	0.210
So_{42}	1.10	0.90	1.11	0.233
So_{43}	1.20	0.80	1.39	0.292
So_{44}	0.90	1.10	1.26	0.265
			4.76	1.00

Source: Authors' research

The obtained results indicate that the greatest importance in this group is indicator So_{43} – An indicator of the usefulness of tourism for the local community, and the least important is indicator So_{41} - Participation in tourism in the local net social product.

Finally, Table 7 shows the importance of the criteria belonging to the environmental condition group.

Table 7: The relative importance of environmental indicators

Indicators	s_j	k_j	q_j	w_j
Ei_{51}		1	1	0.236
Ei_{52}	1.00	1.00	1.00	0.236
Ei_{53}	0.70	1.30	0.77	0.181
Ei_{54}	0.90	1.10	0.70	0.165
Ei_{55}	1.10	0.90	0.78	0.183
			4.25	1.00

Source: Authors' research

Ei $_{51}$ - Changes in land use and *Ei* $_{52}$ – The amount of solid waste per tourist was singled out as the most significant indicators in this group, and *Ei* $_{54}$ – Controlling the pressure of excessive tourist construction was singled out as the least important indicator.

By multiplying the defined local importance of the group of indicators and the associated indicators of sustainable tourism business, the global importance of the associated indicators is defined (Table 8).

Table 8: Final ranking of the evaluated factor

Indicator type		**Importance dimension**	**Indicators**	**Local importance indicators**	**Global importance indicators**
Ec $_1$	Economic	0.157	*Ec* $_{11}$	0.230	0.036
			Ec $_{12}$	0.209	0.033
			Ec $_{13}$	0.161	0.025
			Ec $_{14}$	0.201	0.032
			Ec $_{15}$	0.201	0.032
Ts $_2$	Tourist satisfaction	0.224	*Ts* $_{21}$	0.216	0.048
			Ts $_{22}$	0.240	0.054
			Ts $_{23}$	0.200	0.045
			Ts $_{24}$	0.200	0.045
			Ts $_{25}$	0.143	0.032
Cu $_3$	Culture	0.224	*Cu* $_{31}$	0.206	0.046
			Cu $_{32}$	0.206	0.046
			Cu $_{33}$	0.159	0.036
			Cu $_{34}$	0.176	0.039
			Cu $_{35}$	0.252	0.056
So $_4$	Social	0.187	*So* $_{41}$	0.210	0.039
			So $_{42}$	0.233	0.043
			So $_{43}$	0.292	0.055
			So $_{44}$	0.265	0.050
Ei $_5$	Environmental indicators	0.208	*Ei* $_{51}$	0.236	0.049
			Ei $_{52}$	0.236	0.049
			Ei $_{53}$	0.181	0.038
			Ei $_{54}$	0.165	0.034
			Ei $_{55}$	0.183	0.038

Source: Authors' research

Table 9 shows prioritized indicators in the decreasing order.

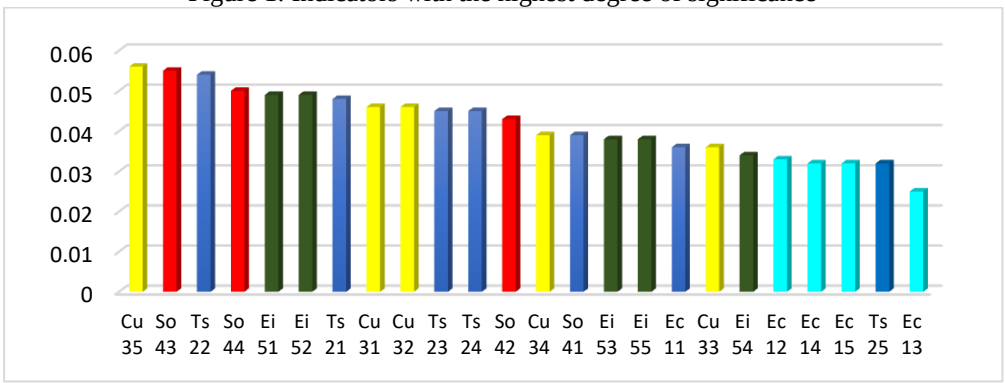
Table 9: Prioritization indicators of sustainable tourism

Types indicators	Global craft	Rank
Cu $_{35}$	0.056	1
So $_{43}$	0.055	2
Ts $_{22}$	0.054	3
So $_{44}$	0.050	4
Ei $_{51}$	0.049	5
Ei $_{52}$	0.049	5
Ts $_{21}$	0.048	6
Cu $_{31}$	0.046	7
Cu $_{32}$	0.046	7
Ts $_{23}$	0.045	8
Ts $_{24}$	0.045	8
So $_{42}$	0.043	9
Cu $_{34}$	0.039	10
So $_{41}$	0.039	10
Ei $_{53}$	0.038	11
Ei $_{55}$	0.038	11
Ec $_{11}$	0.036	12
Cu $_{33}$	0.036	12
Ei $_{54}$	0.034	13
Ec $_{12}$	0.033	14
Ec $_{14}$	0.032	15
Ec $_{15}$	0.032	15
Ts $_{25}$	0.032	15
Ec $_{13}$	0.025	16

Source: Authors' research

Table 9 shows, based on the results and the ranking, that certain indicators occupy the same rank, which means that they have equal importance for the decision-maker. The fact is that it is necessary to consider all the presented indicators that demonstrate the level of sustainability of tourism activities. However, defining their importance allows us to highlight those perhaps more significant than the others in present conditions, and to underline those that require special attention in a certain period.

Figure 1: Indicators with the highest degree of significance



Source: Authors' research

The figure above shows the most important indicators for sustainable tourism.

The first and second-ranked indicators belong to the same category and have a strong connection and influence on each other. The top indicator, Cu $_{43}$, measures the usefulness of tourism for the local community and should be compared with the level of involvement of the local population in tourism, as it affects the community both economic and infrastructurally. This indicator is conditionally linked with the second-ranked indicator, *So* $_{44}$, which measures the influence of international tour operators, because it determines the relationship between direct bookings and bookings made through foreign or domestic tour operators and reflects the usefulness of tourism for the local community. The third-ranked indicator, Cu 35, measures the burden on the budget of local communities and considers the optimal number of accommodation facilities in relation to the local population of the destination. This indicator has a cultural influence on the architectural appearance of the tourist area or place and requires appropriate infrastructure, which can be costly for local communities. Therefore, conducting comprehensive research is crucial to reduce the burden on the budget.

4. Conclusion

This paper created the ranking of groups of indicators and associated indicators that describe the progress of sustainable development of tourism using the method of multi-criteria unlearning, more precisely the PIPRECIA method. Five groups of indicators were evaluated, namely: *Ec* $_1$ - Economic indicators, *Ts* $_2$ - Tourist indicators satisfaction, *Cu* $_3$ – Cultural indicator, *So* $_4$ - Social indicators, and *Ei* $_5$ - Environmental indicators. Each of the indicated group of indicators includes a corresponding set of indicators.

Based on the obtained results, we can conclude that the group of indicators *Ts* $_2$ – Tourist satisfaction, and *Cu* $_3$ – Cultural indicators are greatly important, based on the attitude of the decision maker, while *Ei* $_1$ – Economic indicators have the least importance. Although the economic indicator is usually considered very important and influential, in this case, the satisfaction of tourists is more important because it is crucial for the tourist to be satisfied and to return to the destination again and again. After all, this is the only way to create a base of loyal clients. The group of cultural indicators includes adequate accommodation capacities about the number of inhabitants, the intensity of tourism in and out of season, and adequate provision of the necessary infrastructure that can provide tourists with variety, and complete content, which builds on the indicators related to tourist satisfaction.

The PIPRECIA method proved to be applicable and useful in defining the importance of indicators, i.e. those indicators that require the most attention according to the opinion of the decision maker in terms of improving the sustainability of the tourism business. The goal defined at the beginning, which included determining the significance of the presented set of indicators as well as checking the applicability of the PIPRECIA method, was successfully achieved.

The primary weakness of this study is that the decision-making process involves only one individual, leading to highly subjective results. Moreover, the example presented is hypothetical and not associated with any particular tourist destination. Depending on the tourist destination, as well as on the involved decision makers, it is quite expected that the obtained results will be different compared to those shown here. However, this does not diminish the usefulness and applicability of multi-criteria decision-making methods, because if all aspects are properly established, the definition of relevant results will not be missing. To obtain the most realistic results, it is advisable to include a larger number of decision-makers and to base the calculation procedure on the application of unclear or interval numbers to take into account the variability of the environment to a greater extent.

Applying the appropriate extensions of the PIPRECIA method in sustainable tourism represents critical propositions for future research. The unclear, grey, or rough PIPRECIA method will yield more representative and reliable results because the vagueness will be acknowledged better. Finally, observing the possibilities for applying the MCDM methods in the tourism field will facilitate the decision-making process and enable adequate decisions.

Conflict of interest

The authors declare no conflict of interest.

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