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A Fuzzy TOPSIS Based Decision-Making Model for the Evaluation of Corporate Social Responsibility Projects

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Abstract: Corporate social responsibility (CSR) is a concept that has gained increasing importance in recent years and represents individuals and organizations that conduct their activities with awareness of their social, cultural, economic, and environmental responsibilities. Organizations undertake various projects to provide social benefits, but the cost-benefit balance of these projects must be evaluated to ensure the efficient use of limited resources. Because this process involves a complex decision-making problem involving numerous criteria and uncertainties, multi-criteria decision-making methods that can model uncertainties more realistically contribute significantly to the process.
In this study, the fuzzy TOPSIS method was used to evaluate CSR projects planned for implementation by a district municipality. Based on a literature review and expert opinions, a decision model was created by identifying ten evaluation criteria and seven alternative projects encompassing the economic, social, environmental, and governance dimensions of CSR. The results indicated that a project aimed at strengthening women's roles in social and economic life through women's cooperatives was prioritized. However, a project based on accessibility but weak sustainability and stakeholder engagement was ranked last. These results highlight the importance of considering social contribution, economic development, and sustainable development goals in the evaluation of CSR projects.

Keywords: Social responsibility, corporate social responsibility projects, sustainability, decision making, fuzzy TOPSIS

Kurumsal Sosyal Sorumluluk Projelerinin Değerlendirilmesine Yönelik Bulanık TOPSIS Tabanlı Karar Verme Modeli

Özet: Kurumsal sosyal sorumluluk (KSS), son yıllarda giderek önem kazanan ve faaliyetlerini sosyal, kültürel, ekonomik ve çevresel sorumluluklarının bilincinde olarak yürüten birey ve kurumları temsil eden bir kavramdır. Kurumlar, toplumsal fayda sağlamak amacıyla çeşitli projeler yürütürler, ancak sınırlı kaynakların verimli kullanılmasını sağlamak için bu projelerin maliyet-fayda dengesinin değerlendirilmesi gerekir. Çok sayıda kriter ve belirsizliği içeren bu süreç karmaşık bir karar alma problemi olduğundan, belirsizlikleri daha gerçekçi bir şekilde modelleyebilen çok kriterli karar alma yöntemleri sürece önemli katkı sağlar.
Bu çalışmada, bir ilçe belediyesi tarafından uygulanması planlanan KSS projelerini değerlendirmek için bulanık TOPSIS yöntemi kullanılmıştır. Literatür taraması ve uzman görüşlerine dayanarak, KSS'nin ekonomik, sosyal, çevresel ve yönetişim boyutlarını kapsayan on değerlendirme kriteri ve yedi alternatif proje belirlenerek bir karar modeli oluşturulmuştur. Sonuçlara göre, kadın kooperatifleri aracılığıyla kadınların sosyal ve ekonomik yaşamdaki rollerini güçlendirmeyi amaçlayan bir projeye öncelik verilmiştir. Ancak, erişilebilirliğe dayalı sürdürülebilirliği ve paydaş katılımı zayıf bir proje son sırada yer almıştır. Bu sonuçlar, KSS projelerinin değerlendirilmesinde toplumsal katkı, ekonomik kalkınma ve sürdürülebilir kalkınma hedeflerinin dikkate alınmasının önemini vurgulamaktadır.

Anahtar Kelimeler: Sosyal sorumluluk, kurumsal sosyal sorumluluk projeleri, sürdürülebilirlik, karar verme, bulanık TOPSIS

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1. Introduction

Social responsibility is a concept that goes beyond the support provided by individual interests, or even those that are achievable. It expresses the obligation of organizations and their processes to act in a sensitive, ethical, and sustainable manner for the society and environment in which they operate, as well as for future generations. Accordingly, creating social benefit by going beyond economic interests is essential, and social responsibility is addressed within the framework of volunteering, ethical values, accountability, and sustainable development principles. Today, the understanding of social responsibility is not limited to individuals but also encompasses components in the private, public, civil society, and education sectors [1]. Social responsibility encompasses a wide range of areas, including environmental protection, education, culture, arts, health, human rights, and support for disadvantaged groups. The most fundamental characteristic of this future is the timely expansion of social participation by individuals and their active contribution to this distribution. In this context, social responsibility is not merely a concept of "helping" but also a constructive approach that supports long-term social transformation and sustainable development. Through these partnerships, companies can establish stronger ties with society, enhance their corporate reputation, and generate social benefits [2]. In international literature, this concept is often referred to as “Corporate Social Responsibility” (CSR). This includes not only compliance with legal regulations but also the development of volunteers and their assumption of social and ethical responsibilities [3]. Social responsibility aims to establish a balance between economic development and social welfare, taking people's opinions into account, and implementing environmentally friendly policies [4]. Therefore, companies have recently begun to place greater emphasis on social responsibility [5]. While some studies suggest that academic interest in CSR dates to the 19th century, it has recently been phased out by universities, non-governmental organizations, corporations, and public administrations [6]. Today, with the emergence of advanced social behaviors and the evolution of people's attitudes, their characteristics are more widely observed. They can no longer focus solely on reducing costs and increasing profits. Beyond economic concerns, they must do their utmost to fulfill their social responsibilities [5]. CSR is a commitment to contribute to sustainable economic development by increasing the freedom of life through collaboration with members, their families, the local community, and society at large [6]. Moreover, social responsibility is a critical goal that should not be neglected. Pressure from non-governmental organizations (NGOs), social groups, and the media to be responsive to social action has resulted in significant losses for some companies [5]. Companies demonstrating strong CSR partnerships achieve more positive sales with their units through growth and social capital [7, 8]. Socially responsible businesses are more likely to attract and integrate their interests, and investment in such activities is encouraged. This increases the likelihood of system-wide risk aggregation and sustainable success [7, 8, 9]. Businesses can focus on various social and environmental areas within the scope of CSR, such as green product production, waste reduction, recycling, participation in for-profit activities, employment of minority groups, and the development of community collaboration [5, 8]. Such integrated practices aim to create shared value for both internal users (employees, customers, and known individuals) and communities [8]. The increasing impact of life and its impact on today's world continues to shape the scope of CSR as a management tool. CSR is no longer merely a volunteer-based philanthropic approach, but a comprehensive understanding of sustainability encompassing economic, social, and other aspects [10]. This influence is also reflected in the increasing use of the comprehensive TOPSIS method in evaluating CSR projects. Furthermore, the aim is to examine the performance of suitable ones in terms of cost-benefit.

The primary aim of this study is to analyze CSR projects planned for implementation by a municipality using a multi-criteria evaluation approach to determine which projects are prioritized in terms of social benefit and sustainability. By employing the fuzzy TOPSIS method, which

incorporates uncertainty into the evaluation process in a more realistic manner, the study aims to address a gap in the literature regarding the assessment of CSR projects."
In this context, the research question has been formulated as follows: How does the fuzzy TOPSIS method rank corporate social responsibility projects evaluated across multiple dimensions under conditions of uncertainty, and what insights does this ranking provide for decision-makers in the project prioritization process?"
The second section of the study describes CSR projects and their evaluation processes, while the third section explains the methods used. The fourth section presents the information obtained from the studies, and the final section presents the results and evaluations.

2. Corporate Social Responsibility Projects Introduction

The concept of Corporate Social Responsibility (CSR) originated in the 1950s, emphasizing the accountability of companies toward society. In the present day, many organizations implement CSR initiatives and activities to fulfill their obligations to both society and their stakeholders. This growing engagement is largely driven by increasing social and political pressures associated with challenges such as climate change, environmental degradation, resource depletion, public health crises, and social inequality [11]. According to the World Business Council for Sustainable Development, CSR is "the consistent pursuit of promoting ethical growth and contributing to economic development while improving the lives of employees, their families, local communities, and society as a whole." According to the European Commission, integrated CSR is a concept based on ethical and critical solutions that are socialized across regions and regions based on core values. In this context, responsible business performance has gained importance as it is increasingly recognized as contributing to sustainable business performance. Similarly, the World Business Council for Sustainable Development defines CSR as a process by which employees, their families, local communities, and society in general can improve their lives by adapting to ethical behavior and economic conditions. A company's social responsibility activities have positive effects not only on customer satisfaction, brand image, and customer loyalty, but also on society. Therefore, many businesses view business as a form of social responsibility initiative [8]. A significant milestone in the widespread adoption of CSR practices was the 17 Sustainable Development Goals (SDGs) declared by the United Nations. SDG 8 (decent work and economic growth), SDG 9 (industry, development, and infrastructure), and SDG 12 (responsible consumption and production) address sustainable service delivery [9]. Due to the impact of corporations on the environment and stakeholder expectations, CSR has become an increasingly important topic for industries, end-users, academics, and policymakers. Driven by global competition, companies are focusing not only on generating revenue but also on achieving ethical and publicly acceptable corporate values for all stakeholders, including societies, the environment, and shareholders. This not only provides tangible benefits such as improved reputations, reduced risks, and strengthened stakeholder relationships, but also increases the capacity to develop solutions to social problems [12]. Employee engagement, customer loyalty, and investor trust are positively impacted by CSR practices; the "moral capital" function of CSR makes companies more resilient in times of crisis. In these respects, CSR is an important management tool that instills stakeholder trust and supports sustainable growth. However, measuring and evaluating CSR is a complex process; there is no full consensus in the literature on the definition of the concept, and stakeholder engagement is critical for a successful evaluation [10].

2.1 Evaluation of Corporate Social Responsibility Projects

CSR is based on the understanding that businesses should operate not only for economic profitability but also for social well-being, environmental protection, and ethical responsibilities. Increasing global environmental and social challenges have made the role of businesses in

sustainable development more visible and have transformed CSR projects into a performance indicator that strengthens trust-based relationships with stakeholders and enhances competitiveness. CSR is a dynamic concept and can be managed in various ways through projects [13]. Therefore, project management plays a key role in facilitating CSR objectives; the effective use of tools, knowledge, and skills ensures successful project implementation. CSR strengthens an organization's reputation and credibility, increases employee motivation, and improves cost-effectiveness. Furthermore, in contexts where sustainability pressures are increasing, integrating environmental issues into projects is critical for brand image, trust, and accountability [14]. Especially in the European Union, CSR practices have increasingly become mandatory regulatory requirements. Relevant regulations require businesses to report not only their financial performance but also their environmental and social impacts. This makes CSR projects an integral part of sustainability strategies. Transparent reporting is important for both social trust and ethical management. From an economic perspective, CSR positively impacts customer loyalty, brand equity, and long-term financial performance; therefore, it is seen as a tool for gaining competitive advantage, particularly in Europe [13]. The costs and financial risks associated with implementing CSR are a significant concern for managers. Therefore, criteria such as economic return and cost-benefit analyses can be used in CSR projects because costs directly impact project viability [14]. Project planning, resource allocation, stakeholder collaboration, and motivating employees to contribute to the project are key elements of project management. In project-based companies, due to their strong goal orientation and evolving structure, project management and CSR practices need to be developed together. A shift from traditional procedures with clearly defined stages and milestones to holistic approaches that include greater versatility, and a variety of methodologies is necessary [11]. CSR requires businesses to fulfill their social responsibilities while achieving their economic goals. Given limited resources and rising costs, selecting the most appropriate CSR projects and evaluating their costs is a critical challenge. The four components of CSR (economic, legal, ethical, and philanthropic responsibilities) require managers to identify and consider the interests of stakeholders affected by the organization's actions; therefore, the selection of the most appropriate project should be based on its ability to create both social benefits and value for the company. Furthermore, CSR projects may duplicate or conflict with company objectives due to resource dependencies; if these dependencies are not considered, misallocation and waste of resources can occur. An integrated approach is essential for businesses with limited resources and costs to identify projects that both provide a competitive advantage and add value to society [6].
Selecting suitable projects is the first step in strategic and informed project management in project-based companies. Wrong choices can lead to financial losses and reduced revenue due to wasted time and effort on unprofitable initiatives, while correct choices can lead to increased profits for the company. However, conflicting priorities and numerous alternatives complicate the selection process; balancing financial and strategic priorities, efficient resource allocation across projects, and a systematic decision-making process are essential. Existing research emphasizes the importance of structured processes that include clearly defined stages, appropriate tools and techniques, and the active participation of decision-makers [7]. Decision-makers often must evaluate multiple criteria related to intangible or conflicting characteristics. Therefore, it is necessary to determine which critical factors and objectives should be considered from the results obtained and how projects should be compared and selected [5].

2.2 Literature Review on Corporate Social Responsibility

Literature reveals that businesses are increasingly adopting CSR practices; however, there are various operational challenges and limitations in evaluating these practices [6]. Accordingly, studies on the evaluation of CSR projects in the literature have been systematically reviewed and the relevant findings are presented below.

Khalilzadeh and Salehi [5] present an extended multi-objective project selection problem with fuzzy parameters that aims to minimize total risk and total cost while simultaneously maximizing total project benefits and social responsibility. Tsai et al. [6] proposes an integrated approach integrating DEMATEL, ANP, ZOGP, and ABC methods for the selection and cost evaluation of CSR projects in the hotel industry. The study determined the optimal CSR project portfolio and showed that corporate image development is the most important factor driving CSR practices in hotels. Hernandez et al. [7] developed the interval-valued neutrosophic TOPSIS method for social responsibility-oriented project selection. Sattayapanich et al. [8] examined the factors affecting community participation in environmental CSR projects. In this study, conducted on the example of a sustainable mangrove forest management project in Rayong Province, Thailand, variables affecting the participation of community members (perception of ecological values, CSR credibility, institution-public relationship, ecological knowledge, and expected benefits) were analyzed. Survey data were used in the study, and multiple regression analysis was applied. The results showed that perceived ecological values were the strongest predictor of participation in all project phases. Jovanović et al. [11] analyzed the effects of three dimensions of CSR (ecological, volunteering, and social) on intangible project benefits in project-based enterprises in Serbia using Structural Equation Modeling (SEM). The results showed that the ecological and social dimensions had a significant and positive effect on project benefits, while the volunteering dimension did not have a statistically significant effect. Al-Marri et al. [14] examined how CSR could be improved through a project management approach in organizations in the United Arab Emirates. The study findings revealed that organizations with project management competencies were more successful in developing strategic CSR capacity. Matsutani et al. [9] conducted a critical analysis of CSR projects in Brazilian companies based on the opinions of experienced professionals. Data obtained from bibliographic reviews and semi-structured interviews were evaluated using content analysis, and a SWOT matrix was created based on the results. Lu et al. [10] critically discussed the inherent limitations of CSR evaluation approaches and proposed an SDG-focused, holistic, and comparable evaluation model. Kasradze et al. [13] conducted an analysis based on a literature review to identify and assess the main challenges faced in adopting CSR for sustainability and used the image-fuzzy SWARA-TOPSIS method to rank the performance of EU countries in addressing these challenges. Table 1 presents a comparative overview of the criteria, sub-indicators, and approaches used in the evaluation of CSR projects based on studies conducted in different sectors and contexts.

Table 1. Summary of literature on the evaluation of corporate social responsibility projects

Author (Year)	Subject / Context of the Study	Criterion (s) Used in Evaluation	Sub-Indicators / Dimensions	Method or Approach
Hatunoglu et al. [15]	Evaluation of social responsibility performance of participation banks	GRI criteria (economic, environmental, social)	Human rights, employee practices, community impact, product responsibility	ENTROPY–TOPSIS
Kırkıl and Boran [16]	Examination of CSR projects within the scope of Kotler & Lee’s six social initiatives	Social initiative types (cause-related, volunteer campaign, donation, etc.)	Effectiveness, sustainability, goal alignment, corporate context	Content analysis (qualitative)
Biter [17]	Relationship between social responsibility projects and SDGs in the context of social benefit	SDG compliance, public benefit, inclusiveness, equality	Education, environment, gender equality, poverty reduction	Conceptual analysis
Azak Sungur [18]	Evaluation of CSR projects of pharmaceutical companies in Turkey	Project type, impact area, target audience reach, communication and reporting level	Health, education, environment, community support projects	Situation analysis, document review
Can [19]	CSR projects of chain hotel enterprises	Corporate reputation contribution, social benefit, environmental sensitivity	Education, environment, culture–arts	Survey and content analysis

Büyükşalvarcı et al. [20]	Comparison of CSR projects of hotel enterprises	Project categories: education, health, culture, sports, environment	Impact level, sustainability, social benefit, visibility	Case analysis
Özbay [21]	Examining the relationship between corporate social responsibility index model and financial performance	Family–Society, Environment, Education, Culture–Art, Health, Sports	Impact level, duration, participant count	Document analysis
Yang et al. [22]	Evaluation of social responsibility performance of large-scale infrastructure projects	Social, environmental, economic, governance	Stakeholder participation, traffic safety, local employment, environmental impact, social benefit	Indicator set development + Fuzzy AHP
Chipriyanov [23]	Effects of CSR impact on economic growth and inequality	Contribution to economic growth, employment, income distribution, sustainable development	Macro indicators, comparative analysis	Literature review + methodological analysis
Scelles et al. [24]	Evaluation of a CSR project for disabled sports	Social benefit, stakeholder participation, economic benefit	Social utility, participation rate, cost–benefit ratio	SROI calculation
Stojanović et al. [25]	Measuring CSR perceptions of employees in Bulgaria, Russia, and Serbia based on country scales	Ethics, environmental practices, social contribution, transparency, employee well-being	Awareness, application examples, perceived impact, reporting level	Survey + Entropy–PROMETHEE–GAIA

3. Materials and Methods

Real-life problems involve different options and multiple related criteria that must be considered in the decision-making process. This type of decision-making process is called Multi-Criteria Decision Making (MCDM) and is widely used in fields such as business, education, employment, and household applications [26, 27]. MCDM techniques are used to evaluate and select the best alternative from limited or large data sets [28]. Methods proposed for addressing MCDM problems can be categorized into several groups, including reference point approaches, comparative or relative evaluation techniques, ranking-based approaches, and other hybrid strategies. Among these, one of the most widely used ranking approaches is the TOPSIS method [26], [29]. Originally introduced by Hwang and Yoon (1981) [30], the TOPSIS technique is grounded in the idea that the optimal alternative should be the one nearest to the positive ideal solution (PIS) and farthest from the negative ideal solution (NIS) [26, 31, 32]. The PIS maximizes benefit-type criteria while minimizing cost-type ones, whereas the NIS performs the opposite. By incorporating all attribute information, the TOPSIS method enables a comprehensive and quantitative ranking of the alternatives [26, 32]. One of the main advantages of TOPSIS is its ability to rank alternatives according to their impact using unlimited data for each indicator [32]. The TOPSIS method is considered an important MCDM method used by many researchers, policy makers, stakeholders, and academics in a wide variety of fields. However, this method has some limitations in its interpretation in real life due to its inability to provide clear information about the problem and its inclusion of uncertain issues [30]. When mathematical problems particularly decision-making problems involve uncertainty, classical models become insufficient to provide reliable solutions. Unlike traditional methods that view uncertainty as an undesirable situation, scientists today have developed alternative approaches to manage this situation by accepting it as inevitable. Accordingly, different set theories have been developed in the literature to address uncertainty in mathematical problems. Fuzzy set theory is the most important of these theories [26]. Fuzzy set theory was introduced by Lotfi A. Zadeh in 1965 to mathematically express intuitive reasoning by considering the uncertainty and subjective evaluations in human thought. The main goal of fuzzy logic is to capture the imprecise expressions in human thought and express them with appropriate mathematical tools [30]. This theory argues that the degree of belonging of an element to a set can be expressed by a positive membership value [26]. Fuzzy decision-making is an approach applied in cases where the available information is vague, incomplete, or subject to interpretation. It broadens the scope of traditional decision-making techniques that rely on classical, precise, and binary logic. In fuzzy decision making, input and output variables are defined by fuzzy sets instead of sharp sets. In this way, a variable is allowed to have a membership degree ranging from 0 to 1, rather than being a full member of a set or not being a member at all. Thus, uncertainty and imprecise information are incorporated into the decision process in a more realistic way [31]. With the application of fuzzy set theory to MCDM techniques, triangular, trapezoidal and Gaussian fuzzy numbers began to be used, which led to the development of the fuzzy TOPSIS method [28]. The fuzzy TOPSIS method is an adaptation of TOPSIS to uncertainty and group decision-making processes. It provides more realistic results in situations where there is more than one decision maker and the information is uncertain. Linguistic expressions are used instead of numerical evaluations, and these expressions are converted to appropriate fuzzy numbers. Thus, closeness coefficients are obtained for each alternative and the best alternative is determined [31]. In addition, all the information used in fuzzy TOPSIS is human based. Therefore, the estimation of the values of interest depends on the "reliable, robust, sound, real and believable" level of the information [30]. The algorithm of the fuzzy TOPSIS method is as follows [33];

In the fuzzy TOPSIS approach developed by Chen [33], the process begins with the determination of the decision-maker group. This $E = \{KV_1, KV_2, \ldots, KV_N\}$ is represented by the set of experts who will participate in the decision-making process. After the formation of the expert group, the alternatives to be evaluated $A = \{A_1, A_2, \ldots, A_m\}$ and the criteria that will allow these alternatives to be analyzed against the criteria $K = \{K_1, K_2, \ldots, K_n\}$ are defined as follows. In the next stage, the linguistic expressions (verbal variables) to be used both to determine the importance of the criteria and to evaluate the performance of the alternatives are determined. Decision-makers make their evaluations using these verbal expressions, and these verbal evaluations are converted into appropriate fuzzy number representations, such as triangular fuzzy numbers. Thus, both the criterion weights and the performance values of the alternatives are expressed in fuzzy numbers in a way compatible with uncertainty. The mappings for the fuzzy number representations used in this study are presented in Tables 2 and 3.

Table 2. Variables used in determining the importance weight of the criteria [33]

Linguistic Variables	Triangular Fuzzy Numbers
Very Low (VL)	(0, 0, 0.1)
Low (L)	(0, 0.1, 0.3)
Medium Low (ML)	(0.1, 0.3, 0.5)
Medium (M)	(0.3, 0.5, 0.7)
Medium High (MH)	(0.5, 0.7, 0.9)
High (H)	(0.7, 0.9, 1)
Very High (VH)	(0.9,1,1)

Table 3. Variables used in the evaluation of alternatives [33]

Linguistic Variables	Triangular Fuzzy Numbers
Very Poor (VP)	(0, 0, 1)
Poor (P)	(0, 1, 3)
Medium Poor (MP)	(1, 3, 5)
Fair (F)	(3, 5, 7)
Medium Good (MG)	(5, 7, 9)
Good (G)	(7, 9, 10)
Very Good (VG)	(9, 10, 10)

In order to represent the fuzzy evaluations given by multiple decision-makers for the alternatives and criteria as a single and integrated value, the procedure explained below is followed.

$$\tilde{x}_{ij} = \frac{1}{N}\left[\tilde{x}_{ij}{}^{1}(+)\tilde{x}_{ij}{}^{2}(+)\ldots\ldots\ldots(+)\tilde{x}_{ij}{}^{N}\right] \quad (1)$$

Where, $\tilde{x}_{ij}^{N}$N. represents the evaluation of the decision maker.

To convert the weights obtained from the decision makers $\widetilde{w}_j$ for each criterion into a single common value, Nit is calculated as follows.

$$\widetilde{w}_j = \frac{1}{N}\left[\widetilde{w}_j{}^1(+)\widetilde{w}_j{}^2(+)\ldots\ldots\ldots(+)\widetilde{w}_j{}^N\right] \tag{2}$$

Where $\widetilde{w}_j{}^N$N. indicates the weight of the decision maker.

After combining all fuzzy evaluations of criteria and alternatives into a common value, the decision-making problem is converted into matrix form and expressed as shown below.

$$\widetilde{D} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \cdots & \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix} \qquad \widetilde{W} = [\widetilde{w}_1, \widetilde{w}_2, \cdots \widetilde{w}_n] \tag{3}$$

Where $\tilde{x}_{ij} = (l_{ij}, m_{ij}, u_{ij})$, and $\widetilde{w}_j = (w_{j1}, w_{j2}, w_{j3})$ represent the triangular fuzzy numbers. $\widetilde{D}$, represents the fuzzy decision matrix; $\widetilde{W}$and represents the fuzzy weights matrix.

After constructing the decision matrix, normalization is applied to eliminate differences arising from the measurement units. This process is carried out using Equations (5) and (6), resulting in the normalized fuzzy decision matrix $\tilde{R}$.

$$\tilde{R} = [\tilde{r}_{ij}]_{mxn} \quad i = 1,2,\ldots,m, \qquad j = 1,2,\ldots,n \tag{4}$$

B and C are the benefit and cost criteria:

$$\tilde{r}_{ij} = \left(\frac{l_{ij}}{u_j^+}, \frac{m_{ij}}{u_j^+}, \frac{u_{ij}}{u_j^+}\right), \quad j \in B, \qquad u_j^+ = \max_i u_{ij} \tag{5}$$

$$\tilde{r}_{ij} = \left(\frac{l_j^-}{u_{ij}}, \frac{l_j^-}{m_{ij}}, \frac{l_j^-}{l_{ij}}\right), \quad j \in C, \qquad l_j^- = \min_i l_{ij} \tag{6}$$

where, $r_{ij}, (\forall i, j)$are normalized triangular fuzzy numbers. After the normalized fuzzy decision matrix is obtained, weights are applied by considering the different importance levels of the criteria, thus creating a weighted normalized fuzzy decision matrix.

$$\tilde{V} = [\tilde{v}_{ij}]_{mxn}, \qquad i = 1,2,\ldots\ldots,m \qquad j = 1,2,\ldots\ldots,n \tag{7}$$

where, $\tilde{v}_{ij} = \tilde{r}_{ij}(.)\widetilde{w}_j$ (8)

After the weighted normalized fuzzy decision matrix is obtained, the fuzzy positive ideal solution (FPIS, A^+) and the fuzzy negative ideal solution (FNIS, A^-) are expressed in the following form.

$$A^+ = (\tilde{v}_1{}^+, \tilde{v}_2{}^+, \ldots\ldots, \tilde{v}_n{}^+) \tag{9}$$

$$A^- = (\tilde{v}_1{}^-, \tilde{v}_2{}^-, \ldots\ldots, \tilde{v}_n{}^-) \tag{10}$$

where, $\tilde{v}_{ij}^+ = (1,1,1)$ and $\tilde{v}_{ij}^- = (0,0,0)$ $\qquad j = 1,2,\ldots\ldots,n.$

Afterwards, the distances of each alternative to the positive ideal solution (A^+) and the negative ideal solution (A^-) are determined with the help of the following formulas.

$$d_i^+ = \sum_{j=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^+), \qquad i = 1,2,\ldots\ldots,m \qquad j = 1,2,\ldots\ldots,n \tag{11}$$

$$d_i^- = \sum_{j=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^-), \qquad i = 1,2,\ldots\ldots,m \qquad j = 1,2,\ldots\ldots,n \tag{12}$$

Where, $d_v(a, b)$ represents the distance between two fuzzy numbers, and this distance is calculated using the vertex method specified in equation (13). After determining the distances, the closeness coefficient for each alternative (CC_i) is obtained. This coefficient evaluates the distances of the alternative to both the fuzzy positive ideal solution (A^+) and the fuzzy negative ideal solution (A^-) points.

$$d(a,b) = \sqrt{\frac{1}{3}[(l_a - l_b)^2 + (m_a - m_b)^2 + (u_a - u_b)^2]} \quad d(a,b) \in R^+ \tag{13}$$

The closeness coefficient of each alternative is calculated using the formula below:

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-}, \; i = 1,2,\ldots\ldots,m \tag{14}$$

4. Findings

The criteria to be used in evaluating corporate social responsibility projects were determined based on a comprehensive literature review and the opinions of an expert group consisting of two industrial engineers, a sustainability expert, and a sociologist. This holistic approach encompasses the economic, social, environmental, and governance dimensions of CSR. The alternative CSR projects to be evaluated were selected from among those planned for implementation by a district municipality with a large population. The decision-making model, which includes the identified criteria and alternative CSR projects, is presented in Figure 1.

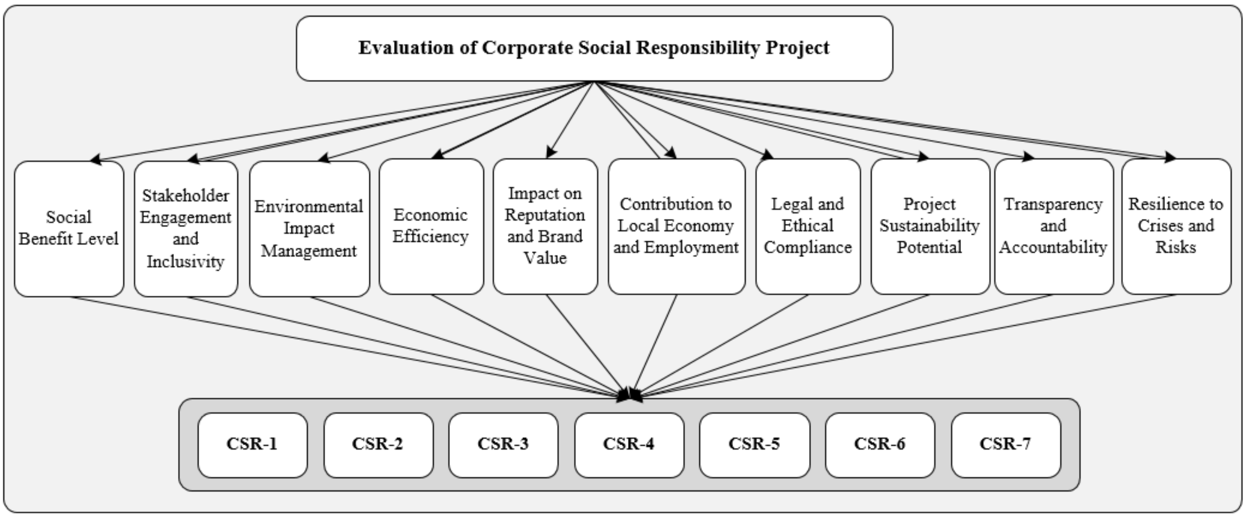

Figure 1. Decision-making model created for the evaluation of CSR projects

Step 1: In this study, CSR projects will be evaluated according to the criteria and alternatives presented in Figure 1 using the steps of Chen's [33] fuzzy TOPSIS method algorithm. First, the evaluation criteria were evaluated by a total of four decision-makers: two industrial engineers, a sustainability expert, and a sociologist, based on a consensus using the linguistic variables presented in Table 2, and the evaluation results are presented in Table 4.

Table 4. Level of importance of CSR projects evaluation criteria

Criteria	Symbol	Linguistic Assessment	
		Level of Importance	Triangular Fuzzy Numbers
Social Benefit Level	C1	VH	(0.9, 1, 1)
Stakeholder Engagement and Inclusivity	C2	H	(0.7, 0.9, 1)
Environmental Impact Management	C3	H	(0.7, 0.9, 1)
Economic Efficiency	C4	H	(0.7, 0.9, 1)
Impact on Reputation and Brand Value	C5	MH	(0.5, 0.7, 0.9)
Contribution to Local Economy and Employment	C6	MH	(0.5, 0.7, 0.9)
Legal and Ethical Compliance	C7	H	(0.7, 0.9, 1)
Project Sustainability Potential	C8	H	(0.7, 0.9, 1)
Transparency and Accountability	C9	MH	(0.5, 0.7, 0.9)
Resilience to Crises and Risks	C10	H	(0.7, 0.9, 1)

Step 2: Alternative CSR projects were evaluated with linguistic expressions based on the criteria determined by the same decision makers and the evaluation results obtained are shown in Table 5.

Table 5. Evaluation of alternative CSR projects by decision makers

Criteria	Alternative CSR Projects						
	CSR-1	CSR-2	CSR-3	CSR-4	CSR-5	CSR-6	CSR-7
C1	VG	G	MG	G	VG	G	MG
C2	G	VG	G	G	G	MG	G
C3	MP	P	F	F	G	G	MP
C4	MG	MG	F	MG	G	G	P
C5	G	G	MG	F	G	G	MG
C6	G	G	MP	P	MG	VG	P
C7	G	MG	MG	G	VG	G	G
C8	MG	F	F	MG	VG	G	MP
C9	MG	F	F	MG	G	MG	MP
C10	MG	F	MP	MG	G	G	MP

Step 3: The alternatives given in Table 5 were converted into triangular fuzzy numbers given in Table 3 and the fuzzy decision matrix given in Table 6 was created.

Table 6. Fuzzy decision matrix

Criteria	Alternative CSR Projects						
	CSR-1	CSR-2	CSR-3	CSR-4	CSR-5	CSR-6	CSR-7
C1	(9,10,10)	(7,9,10)	(5,7,9)	(7,9,10)	(9,10,10)	(7,9,10)	(5,7,9)
C2	(7,9,10)	(9,10,10)	(7,9,10)	(3,5,7)	(7,9,10)	(5,7,9)	(7,9,10)
C3	(1,3,5)	(0,1,3)	(0,1,3)	(3,5,7)	(3,5,7)	(0,1,3)	(1,3,5)
C4	(5,7,9)	(5,7,9)	(3,5,7)	(5,7,9)	(3,5,7)	(7,9,10)	(1,3,5)
C5	(7,9,10)	(7,9,10)	(5,7,9)	(3,5,7)	(7,9,10)	(7,9,10)	(5,7,9)
C6	(7,9,10)	(7,9,10)	(1,3,5)	(0,1,3)	(5,7,9)	(9,10,10)	(0,1,3)
C7	(7,9,10)	(7,9,10)	(5,7,9)	(7,9,10)	(7,9,10)	(7,9,10)	(7,9,10)
C8	(5,7,9)	(3,5,7)	(3,5,7)	(5,7,9)	(9,10,10)	(7,9,10)	(1,3,5)
C9	(5,7,9)	(3,5,7)	(3,5,7)	(5,7,9)	(7,9,10)	(5,7,9)	(1,3,5)
C10	(5,7,9)	(3,5,7)	(1,3,5)	(5,7,9)	(7,9,10)	(7,9,10)	(1,3,5)

Step 4: The fuzzy decision matrix given in Table 6 was normalized using equation (5) so that all evaluation criteria were considered as benefit criteria and the benefits of the criteria were maximized, and the normalized fuzzy decision matrix in Table 7 was created.

Table 7. Normalized fuzzy decision matrix

Criteria	Alternative CSR Projects						
	CSR-1	CSR-2	CSR-3	CSR-4	CSR-5	CSR-6	CSR-7
C1	(0.9,1,1)	(0.7,0.9,1)	(0.5,0.7,0.9)	(0.7,0.9,1)	(0.9,1,1)	(0.7,0.9,1)	(0.5,0.7,0.9)
C2	(0.7,0.9,1)	(0.9,1,1)	(0.7,0.9,1)	(0.3,0.5,0.7)	(0.7,0.9,1)	(0.5,0.7,0.9)	(0.7,0.9,1)
C3	(0.14,0.43,0.71)	(0,0.14,0.43)	(0,0.14,0.43)	(0.43,0.71,1)	(0.43,0.71,1)	(0,0.14,0.43)	(0.14,0.43,0.71)
C4	(0.5,0.7,0.9)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.7,0.9,1)	(0.1,0.3,0.5)
C5	(0.7,0.9,1)	(0.7,0.9,1)	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.7,0.9,1)	(0.7,0.9,1)	(0.5,0.7,0.9)
C6	(0.7,0.9,1)	(0.7,0.9,1)	(0.1,0.3,0.5)	(0,0.1,0.3)	(0.5,0.7,0.9)	(0.9,1,1)	(0,0.1,0.3)
C7	(0.7,0.9,1)	(0.7,0.9,1)	(0.5,0.7,0.9)	(0.7,0.9,1)	(0.7,0.9,1)	(0.7,0.9,1)	(0.7,0.9,1)
C8	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0.5,0.7,0.9)	(0.9,1,1)	(0.7,0.9,1)	(0.1,0.3,0.5)
C9	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.3,0.5,0.7)	(0.5,0.7,0.9)	(0.7,0.9,1)	(0.5,0.7,0.9)	(0.1,0.3,0.5)
C10	(0.5,0.7,0.9)	(0.3,0.5,0.7)	(0.1,0.3,0.5)	(0.5,0.7,0.9)	(0.7,0.9,1)	(0.7,0.9,1)	(0.1,0.3,0.5)

Step 5: Considering that each evaluation criterion has different importance weights for decision makers, the weighted normalized fuzzy decision matrix is obtained using equation (8) and is given in Table 8.

Table 8. Weighted normalized fuzzy decision matrix

Criteria	Alternative CSR Projects						
	CSR-1	CSR-2	CSR-3	CSR-4	CSR-5	CSR-6	CSR-7
C1	(0.81,1,1)	(0.63,0.9,1)	(0.45, 0.7, 0.9)	(0.63,0.9,1)	(0.81,1,1)	(0.63,0.9,1)	(0.45, 0.7, 0.9)
C2	(0.49,0.81,1)	(0.63,0.9,1)	(0.49,0.81,1)	(0.21, 0.45, 0.7)	(0.49,0.81,1)	(0.35, 0.63, 0.9)	(0.49,0.81,1)
C3	(0.1, 0.39, 0.71)	(0,0.13,0.43)	(0,0.13,0.43)	(0.3,0.64,1)	(0.3,0.64,1)	(0,0.13,0.43)	(0.1, 0.39, 0.71)
C4	(0.35, 0.63, 0.9)	(0.35, 0.63, 0.9)	(0.21, 0.45, 0.7)	(0.35, 0.63, 0.9)	(0.21, 0.45, 0.7)	(0.49,0.81,1)	(0.07,0.27,0.5)
C5	(0.35, 0.63, 0.9)	(0.35, 0.63, 0.9)	(0.25, 0.49, 0.81)	(0.15, 0.35, 0.63)	(0.35, 0.63, 0.9)	(0.35, 0.63, 0.9)	(0.25, 0.49, 0.81)
C6	(0.35, 0.63, 0.9)	(0.35, 0.63, 0.9)	(0.05, 0.21, 0.45)	(0,0.07,0.27)	(0.25, 0.49, 0.81)	(0.45, 0.7, 0.9)	(0,0.07,0.27)
C7	(0.49,0.81,1)	(0.49,0.81,1)	(0.35, 0.63, 0.9)	(0.49,0.81,1)	(0.49,0.81,1)	(0.49,0.81,1)	(0.49,0.81,1)
C8	(0.35, 0.63, 0.9)	(0.21, 0.45, 0.7)	(0.21, 0.45, 0.7)	(0.35, 0.63, 0.9)	(0.63,0.9,1)	(0.49,0.81,1)	(0.07,0.27,0.5)
C9	(0.25, 0.49, 0.81)	(0.15, 0.35, 0.63)	(0.15, 0.35, 0.63)	(0.25, 0.49, 0.81)	(0.35, 0.63, 0.9)	(0.25, 0.49, 0.81)	(0.05, 0.21, 0.45)
C10	(0.35, 0.63, 0.9)	(0.21, 0.45, 0.7)	(0.07,0.27,0.5)	(0.35, 0.63, 0.9)	(0.49,0.81,1)	(0.49,0.81,1)	(0.07,0.27,0.5)

Step 6: The distances of the alternative CSR projects to the fuzzy positive ideal solution were calculated using Equation (11), and their distances to the fuzzy negative ideal solution were calculated using Equation (12). The results are presented in Table 9.

Table 9. d_i^+ and d_i^- values

	d_i^+							d_i^-						
	CSR-1	CSR-2	CSR-3	CSR-4	CSR-5	CSR-6	CSR-7	CSR-1	CSR-2	CSR-3	CSR-4	CSR-5	CSR-6	CSR-7
C1	0.11	0.22	0.37	0.22	0.11	0.22	0.37	0.94	0.86	0.71	0.86	0.94	0.86	0.71
C2	0.31	0.22	0.31	0.58	0.31	0.44	0.31	0.80	0.86	0.80	0.50	0.80	0.67	0.80
C3	0.65	0.83	0.83	0.45	0.45	0.83	0.65	0.47	0.26	0.26	0.71	0.71	0.26	0.47
C4	0.44	0.44	0.58	0.44	0.58	0.31	0.74	0.67	0.67	0.50	0.67	0.50	0.80	0.33
C5	0.44	0.44	0.54	0.65	0.44	0.44	0.54	0.67	0.67	0.57	0.43	0.67	0.67	0.57
C6	0.44	0.44	0.78	0.89	0.54	0.37	0.89	0.67	0.67	0.29	0.16	0.57	0.71	0.16
C7	0.31	0.31	0.44	0.31	0.31	0.31	0.31	0.80	0.80	0.67	0.80	0.80	0.80	0.80
C8	0.44	0.58	0.58	0.44	0.22	0.31	0.74	0.67	0.50	0.50	0.67	0.86	0.80	0.33
C9	0.54	0.65	0.65	0.54	0.44	0.54	0.78	0.57	0.43	0.43	0.57	0.67	0.57	0.29
C10	0.44	0.58	0.74	0.44	0.31	0.31	0.74	0.67	0.50	0.33	0.67	0.80	0.80	0.33

Step 7: Based on the d_i^+ and d_i^- distances calculated for each evaluation criterion, the closeness coefficients (CC_i) of each alternative CSR project were computed using Equation (14), and the results are presented in Table 10.

Table 10. Alternative CSR projects $d_i^{+,}$ d_i^- and CC_i values

	CSR-1	CSR-2	CSR-3	CSR-4	CSR-5	CSR-6	CSR-7
d_i^+	4,102	4,716	5,825	4,961	3,716	4,085	6,078
d_i^-	6,897	6,182	5,027	6,005	7,284	6,900	4,776
CC_i	0.627	0.567	0.463	0.548	0.662	0.628	0.440
Ranking	**3**	**4**	**6**	**5**	**1**	**2**	**7**

According to the results obtained from the method, among the alternative CSR projects, the CSR-5 project had the highest value (0.662) and ranked first. This project is followed by CSR-6 (0.628) and CSR-1 (0.627). Therefore, these three projects demonstrate stronger performance in the social, economic, and environmental dimensions. The CSR-7 project (0.440), with the lowest closeness coefficient, ranked last, being the option farthest from the ideal solution. These results suggest that prioritizing the implementation of CSR-5, CSR-6, and CSR-1 projects in decision-makers' resource allocation and prioritization processes would be a more rational and strategic choice.
Then, sensitivity analysis was performed based on the scenarios given in Table 11 in order to determine how the rankings obtained from the fuzzy TOPSIS method are affected by the change of the criteria weights and to make a more precise evaluation.

Table 11. Scenario combinations created with different criteria weights

Scenario	Combinations	Scenario	Combinations
S-1	C1 Very Low, Other Criteria Current		
S-2	C2 Very Low, Other Criteria Current	S-12	C1 Very High, Other Criteria Current
S-3	C3 Very Low, Other Criteria Current	S-13	C2 Very High, Other Criteria Current
S-4	C4 Very Low, Other Criteria Current	S-14	C3 Very High, Other Criteria Current
S-5	C5 Very Low, Other Criteria Current	S-15	C4 Very High, Other Criteria Current
S-6	C6 Very Low, Other Criteria Current	S-16	C5 Very High, Other Criteria Current
S-7	C7 Very Low, Other Criteria Current	S-17	C6 Very High, Other Criteria Current
S-8	C8 Very Low, Other Criteria Current	S-18	C7 Very High, Other Criteria Current
S-9	C9 Very Low, Other Criteria Current	S-19	C8 Very High, Other Criteria Current
S-10	C10 Very Low, Other Criteria Current	S-20	C9 Very High, Other Criteria Current
S-11	C1 Very Low, Other Criteria Current	S-21	C10 Very High, Other Criteria Current

During the sensitivity analysis, scenarios were created in which the lowest and highest weights were assigned to each criterion, while the weights of the others remained constant, as shown in Table 11. The rankings of CSR projects obtained in the scenarios are given in Figure 2.

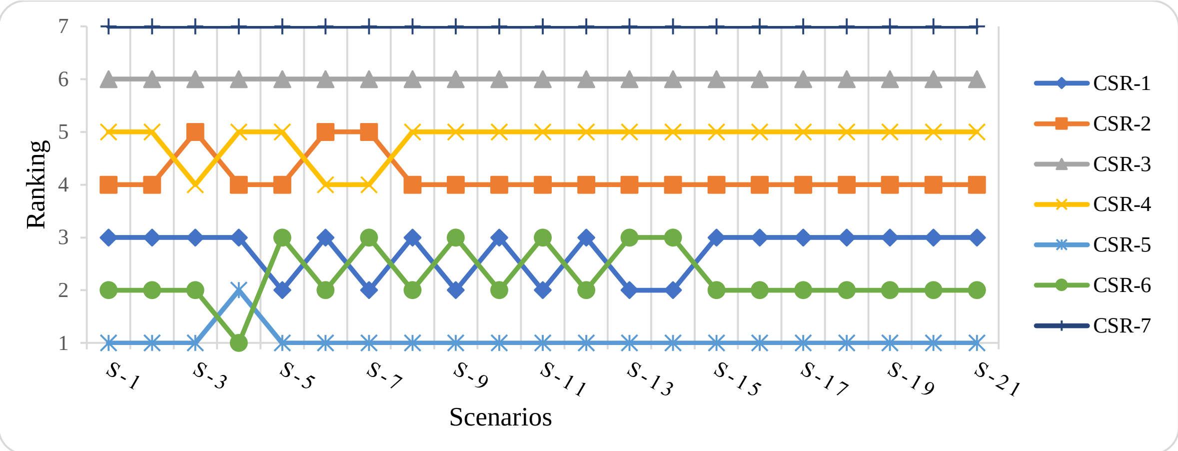

Figure 2. Sensitivity analysis results

When the sensitivity analysis results presented in Figure 2 are examined, the CSR-5 project ranked first in all scenarios except for the S-4 scenario, where only the "Environmental Impact Management" criterion was given the lowest importance (second). The CSR-6 project ranked second in most scenarios, CSR-3 ranked sixth in all scenarios, and CSR-7 ranked last in all scenarios. These results demonstrate that the decision model yields consistent results under different criterion weights, without relying on a single criterion. Therefore, the sensitivity analysis also supports the view that the CSR-5 project is the first CSR project to be implemented for this municipality, which has a project implementation plan.

5. Conclusion and Evaluation

Social responsibility has become a fundamental element in today's world, as important as production itself. In this context, businesses are undertaking various social responsibility projects to both strengthen their corporate reputations and generate social benefits. However, to manage the resources used in these projects efficiently, it is crucial to prioritize projects in terms of cost and benefit. This process is a complex decision-making problem involving numerous variables and uncertainties. Therefore, the use of fuzzy MCDM methods, which can address uncertainties more realistically, offers significant advantages.

In this study, seven CSR projects planned for implementation by a district municipality were evaluated using the fuzzy TOPSIS method, based on established criteria. This method allowed the municipality to prioritize projects to ensure more efficient use of its resources. According to the results, the CSR-5 project ranked first for its structure that supports women's participation in the employment process and income generation. This project demonstrates high alignment with social contribution, economic development, and sustainable development goals. Conversely, despite its awareness-raising value in terms of accessibility, the CSR-7 project, which was deemed weak in terms of sustainability, stakeholder engagement, and permanence, ranked last.

The findings of this study are consistent with previous research in the literature that evaluates CSR projects using multi-criteria decision-making methods. In particular, the results indicate that social benefit, sustainability, and economic impact are key determinants align with the findings of studies such as Tsai et al. [6], Hernandez et al. [7], and Lu et al. [10]. Therefore, working with different expert groups may lead to the identification of additional criteria and potentially yield different weighting results. Moreover, evaluating a larger number of CSR projects in future studies could further test the robustness and sensitivity of the method. Furthermore, the model was applied solely with the fuzzy TOPSIS method. Thus, future research may employ fuzzy AHP, Pythagorean fuzzy TOPSIS, interval-valued fuzzy approaches, or hybrid MCDM models to conduct more comprehensive analyses. Applications with different sectors, institutions, and larger decision-maker groups would significantly contribute to the generalizability of the model.

The obtained results demonstrate that the application of the fuzzy TOPSIS method in the evaluation of CSR projects is an effective and appropriate approach. This study serves as a pioneering example of applying this method to CSR projects and suggests that future studies may employ hybrid MCDM approaches to conduct more comprehensive analyses of such projects.

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