A Systematic Risk Management Model for Social Innovation Projects

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Abstract: - Due to limited and diverse resources, risk management has become a critical issue in social innovation projects. The prioritization of risks in such projects involves multiple and often conflicting criteria. Multi-Criteria Decision Making (MCDM) methods are suitable for explicitly evaluating these criteria in decision-making and prioritization processes. In complex problems like risk management, decision-makers tend to rely on imprecise rather than precise information. Fuzzy set theory effectively addresses the inherent uncertainty and imprecision in such contexts. In particular, hesitant fuzzy sets offer an enhanced ability to represent uncertain and ambiguous expert judgments. In this study, we propose a risk management framework for social innovation projects. First, a comprehensive literature review is conducted to identify relevant risks. Then, a fuzzy MCDM approach based on the Analytic Hierarchy Process (AHP) and extended using hesitant fuzzy sets is employed to prioritize these risks. From a managerial perspective, the proposed model provides a systematic tool to evaluate and classify social innovation projects across a risk spectrum, thereby supporting more informed and effective risk assessment and prioritization.

Key-Words: - Risk management; Social innovation; Project risk assessment; Risk prioritization; Multi-criteria decision making; MCDM; Hesitant fuzzy AHP; Hesitant fuzzy sets; Fuzzy decision making; Project management.

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1 Introduction

Risk management is a fundamental concept in the public and private sectors [1]. An uncertain event that may adversely affect a project is called a project risk [2], while risk management is defined as the identification, prioritization, and evaluation of risks associated with a project or business and taking actions to monitor and control the probability of possible unfortunate events and minimize their effects [3]. Since risk is inherently linked to uncertainty, it concerns potential outcomes rather than deterministic ones, making it essential for organizations to understand not only the likelihood of adverse events but also their possible impact on organizational performance and sustainability [4]. Risk management remains one of the main areas of interest for researchers and practitioners in project management, and it should be considered as a component of any project management

methodology rather than an independent function [5], [6]. Project risk management, which is accepted in view of project management as a life cycle process, is a process used in project definition, planning, execution, control, and completion stages [6]. Project risk management increases the success of a project against time, cost, ill-communication, and quality non-achievement as it has a proactive structure that includes planning and executing risks based on anticipating future events [7], [8].

Innovation projects can be regarded as a vital indicator of competitive advantage in organizations that aim to integrate social needs into their products and services. The innovation process proceeds in an inexplicit risk environment. However, the integration of innovation and risk management models can eliminate this problem [9]. Innovation can be revealed in different types bringing together a novelty and a business model [10]. Among different forms of innovation, social innovation, which can be a product, production process, or technology, but it can also be a principle, an idea, a piece of legislation, a social movement, an intervention, or some combination of them, has now become critical for many partners (nonprofits, businesses, and governments) interested in creating mutually beneficial outcomes [11].

Social innovation is extended to all kinds of social needs and all kinds of fields, from working conditions and education to community development and health [12]. Like many other innovative efforts, social innovation projects are proposed to develop novel approaches and create social impact. Social innovation includes natural science and technology-based and social sciences, as it is based on human activities [13], [14] where risk occurs [5] from different sources. Since social innovation project involves human activities, limited resources, a large number of actors, intense communication, as well as many conflicting criteria, risk management should be an integral part of social innovation. Therefore, the prioritization of social innovation risks, which is one of the first steps in risk management, should be performed with an appropriate framework. In this context, Multi-criteria Decision Making (MCDM), a branch of operations research, can be considered as an effective way for addressing risk management in social innovation projects since MCDM can explicitly evaluate multiple conflicting criteria for decision-making and prioritization problems. In MCDM literature, a variety of proposed methods such as Analytic Hierarchy Process (AHP) [15], TOPSIS [16], [17], VIKOR [18], ELECTRE [19] gives the path for providing appropriate solutions for project risk management problems.

Companies, governments, and the non-profit sector need to openly share ideas and technologies for bringing solutions to social innovation projects. Thus, the initiative to bring together different eligible partners and enable them to communicate and collaborate among themselves happens [12]. Complexity arises when people with different interests, loyalties, and cultures interact with a particular project or program [20]. In this context, since social innovation projects have human activities and intensive communication between stakeholders, they contain imprecision and subjective judgments. A significant measure of human judgment with a subjective issue is required to deal with all the complex people-oriented and technology-driven success factors in projects [21]. In such complex decision-making problems, such as risk management in social innovation projects, decision makers are prone to use imprecise knowledge rather than precise. The fuzzy set theory provides formalized tools to deal with the imprecision intrinsic in these kinds of problems. The fuzzy sets enable us to represent better knowledge under uncertainty and imprecision. Thus, many crisp methods have been extended by fuzzy sets in order to solve real-world problems. One of the most critical aspects of fuzzy logic applications is the utilization of linguistic variables in order to capture a range of numerical values.

In this study, a framework for risk management in social innovation projects is proposed. First, a literature review is performed to identify risks associated with social innovation projects, and then a fuzzy MCDM model is used to prioritize these risks. Since classical MCDM techniques, using crisp values to represent the decision makers' evaluations, neglect imprecision and vagueness in project risk management, we will extend the AHP by using fuzzy sets. The evaluations of decision makers will be collected as pairwise comparisons using linguistic terms. The linguistic terms will be transferred to fuzzy numbers. The chapter has two main managerial implications. Firstly, the proposed methodology provides a systematic tool for managers to distribute social innovation projects through the risk spectrum. Secondly, the fuzzy AHP approach can lead managers to assess and prioritize the project risks. Hesitant fuzzy sets are one of the fuzzy sets' extensions. When decision-makers are hesitant on evaluations, hesitant fuzzy sets enable us to reflect this hesitancy. In this study, a hesitant fuzzy AHP methodology is utilized to represent the hesitancy of the decision-makers.

The rest of this study proceeds as follows. The relevant literature is reviewed in Section 2. Section 3 presents the risks and sub-risks of social innovation projects. The risk hierarchy is given in this section. Section 4 includes the utilized methodology. The application and the results of the application are given in Section 5. Section 6 concludes and gives further suggestions.

2 Literature Review

Project management is the adaptive and effective use of resources to meet project goals and requirements [22]. Therefore, the need to identify a project's uncertainties, estimate their impact, analyze their interactions and control them within a risk management structure has recently been realized in many science and engineering projects that have a high level of risk [23]. Different risk management models have been proposed during the last few decades to increase the success of projects. It is possible to divide the methods used in risk management: qualitative [24], SWOT [25], QEC [26] analysis, and quantitative techniques (probability distribution, decision tree analysis, etc.) [27]. Risk management models are proposed in the field of small and medium enterprises (SMEs) [7], information technology (IT) [3], [28], electric power engineering [29], construction projects [8], [30], [31] and innovation projects [32], [33], [34].

Due to the complex structure of innovation projects, uncertainty and risk are considered as the objective reality of an innovation project and affect all stages. According to [35], innovation and risk-taking are inextricably linked. Therefore, risk management, which takes many risk factors into account, is essential for innovation projects [36]. [32] divided the innovation project risks into operational risks, business risks and political risks. [34] presented a technology innovation risk assessment system model in high technology enterprises in eight dimensions: technology risk, capital risk, patent risk, talent risk, management risk, policy risk, industrial risk, and market risk. Unlike non-dynamic risk models in the literature, [37] created a risk assessment system based on the rigorous mathematical apparatus of classical control theory to forecast the risks of investing in construction projects. [9] combined the innovation process and the project risk management process and created a theoretical framework used to manage innovation risk in several companies. [36] aimed to limit the factors that reduce the design variable of the investment efficiency criterion to the critical limit by creating a risk management model with computer-aided design for innovation projects in the context of globalization. [33] demonstrated that complexity theory yields successful results in reducing energy innovation projects' risks. Risk management models in innovation projects were presented in different project types such as collaborative innovation projects [38] and technological innovation projects [39].

Innovations handle social problems or social requirements, while social innovation is a novel solution that is more effective and sustainable than existing solutions for a social problem and creates value for society as a whole rather than private individuals [40], [41]. [42] used the term social innovation to achieve the desired results of a technological innovation for social or social benefits, as opposed to profit maximization and considered social innovation as both a process and a result. Social innovation has been attracting attention in both academic studies and practices in the last decade. However, many social innovation projects fail to achieve a wider impact [43]. Especially, working with multiple actors, particularly on participatory or co-design processes, creates risks [44]. Therefore, an overview of the risk and social innovation literature is provided. According to [45], social innovation has risks of conceptual stretching, which reduces an idea's practical value due to the current lack of clarity. [35] presented a framework for understanding and negotiating risk in social innovation in public services rather than risk minimization or management. This framework has two propositions: (1) risk management approaches should distinguish between risk and uncertainty, as well as their potential impact on innovation, (2) risk management needs to distinguish between hard and soft approaches to risk management. Because of the importance of reputational risk, innovation in the context of public policy requires a risk management framework beyond traditional models [35]. [46] stressed the dimensions of social innovation on the satisfaction of human needs, social relations changes, and increasing socio-political capacity and accessing resources. Similarly, recent work applying a multi-level perspective to landslide risk reduction demonstrates how grassroots, nature-based innovations such as the implementation of vetiver grass can evolve from niche community initiatives into institutionalized risk governance mechanisms when aligned with supportive policy structures [47]. This study highlights the systemic and governance-related dimensions of risk in social innovation processes, particularly in contexts characterized by institutional fragmentation and limited regulatory

capacity. [48] argued that the fast policy approach, which is mentioned as a risk, was one of the problems of social innovation. [49] focused on anticipated risks and precarity in a social innovation design to alleviate perceived entrenched place-based disadvantage. In the innovation and risk literature, there are studies to understand and negotiate the risk in innovation rather than risk minimization, prioritization, and management. Unfortunately, there are not enough risk management studies in the social innovation literature according to the best knowledge of the authors.

A fuzzy social innovation risk evaluation model is proposed in this study. Therefore, it will be meaningful to indicate fuzzy logic-oriented risk models. Prior risk assessment work based on fuzzy theory has introduced several applications. The fuzzy set theory provides more accurate expert judgment in complex and almost unpredictable models, where descriptions of activities and observations are imprecise, vague, and uncertain [8]. Fuzzy inference systems (FISs) are developed to evaluate the innovation risk for pharmaceutical laboratories [50], [51] and the design phase of a piping system. Fuzzy set theory is used in project risk management because of the benefits of analyzing many linguistic parameters and providing a holistic view of project risk management [30]. [31] developed the fuzzy logic-based risk assessment without responses against risks in construction projects. However, highway construction project risks [52] and outsourcing information technology projects risks [28] identified and prioritized with fuzzy FMEA and fuzzy AHP, respectively; further, appropriate responses for these risks also identified in the related papers.

According to the literature review, various research gaps have been observed. Risk prioritization has not been performed for a social innovation project in the context of project risk management. A multi-criteria decision-making method, that will include fuzzy logic in risk management in order to cope with human judgments in social innovation projects has not been applied before.

Consequently, the study's potential contribution is to develop a social innovation project assessment and risk management framework that comprehensively addresses critical risk factors. This contribution is essential for three perspectives: (1) to make social innovation projects succeed faster in creating improvements for the benefit of society, (2) to adopt project management and risk management for social innovation projects, (3) to create a fuzzy multi-criteria decision-making structure so that the subjectivity in social innovation projects is handled with more accurately.

3 Risk Prioritization of Social Innovation Projects

In social innovation projects, stakeholders usually have very diverse backgrounds and usually work in very different sectors with various institutional cultures [9]. This stricter increases the difficulties in risk management. Managing communication between the partners is a vital element of risk management in social innovation projects. In order to manage the risk in such projects, a solid risk management structure should be developed. Defining the risk elements and evaluating their impact with a multi-criteria decision-making approach is very beneficial for a reliable risk management approach.

In this study, we categorize the social innovation project risks under three main categories based on literature. Risks related to markets are crucial for the success of social innovation projects [53], [54]. When the social innovation projects face market risks, the final output is not used by the end-users. Risks related to the markets involve financial risks, health, and safety risks, and publicity risks.

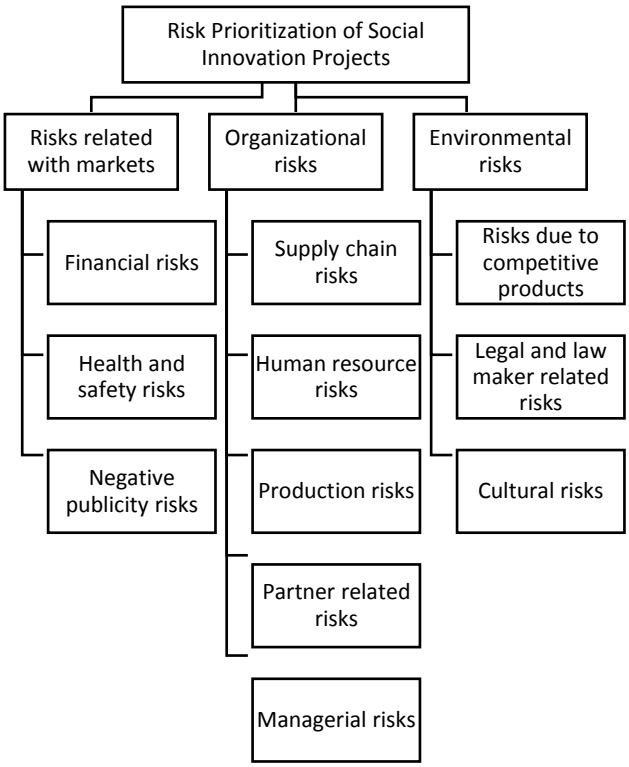


Fig. 1: Hierarchy of the risks in social innovation projects
Source: Created by the authors.

Organizational risk is another main risk group where the product or service production is in danger when faced with organizational risks [55]. Organizational risks involve supply chain risks, human resource risks, production risks, partner-related risks, and managerial risks.

The third risk group is the general environment risks. Risks due to competitive products, legal and lawmaker-related risks, and cultural risks are grouped under this group. According to [56], the risks and competition have a high impact on innovation choice. Organizations should consider legal and lawmaker-related risks in innovation projects [57]. Culture is an important aspect that shapes social innovation projects. Managing cultural risks is vital for the success of social innovation projects [58], [59]. The hierarchy of the risks in social innovation projects is given in Figure 1.

4 Hesitant Fuzzy Analytical Hierarchy Process

The risks of social innovation projects can be evaluated by using the analytical hierarchy process. AHP methodology evaluates the importance of the main and sub risk criteria by using pairwise comparisons. The weights of the risk criteria can be better defined with AHP. Yet, the hesitancy of the decision-makers can complicate the evaluation process. Hesitant Fuzzy Sets, one of the extensions of classical fuzzy sets, are excellent tools for reflecting the decision makers' hesitancy on the evaluation process. In this study, hesitant AHP methodology is utilized for evaluating the social innovation project risks.

4.1 Preliminaries

A hesitant fuzzy set (HFS) on a fix set S, can be defined as in Eq. (1).

$$HFS = \{< s, h(s) > \mid s \epsilon S\} \quad (1)$$

where $h(s)$ denotes membership degrees that ranges between [0, 1].

Decision-makers may hesitate while selecting the appropriate linguistic expression. In the classical fuzzy linguistic approaches, a single expression should be selected, which limits the decision-makers. Hesitant Fuzzy Linguistic Terms Sets (HFLTS) introduced by [60] can be used when the decision-makers hesitate between several linguistic expressions. HFLTS itself, as well as the methods developed for HFLTS enable representing and solving multiple linguistic assessments mathematically. The operations on HFLTS can be given as follows:

Let $HFLTS_s$ be a hesitant fuzzy linguistic term set and $L = \{l_0, l_1, \dots, l_g\}$ be the ordered finite subset of consecutive linguistic terms. The linguistic expressions can be converted into HFLTS by using C_H convergence a function. C_H can be defined as in Eq. (2-7).

$$C_H(l_i) = \{l_i | l_i \in L\} \quad (2)$$

$$C_H(at\ most\ l_i) = \{l_j | l_j \in L\ and\ l_j \leq l_i\} \quad (3)$$

$$C_H(lower\ than\ l_i) = \{l_j | l_j \in L\ and\ l_j < l_i\} \quad (4)$$

$$C_H(at\ least\ l_i) = \{l_j | l_j \in L\ and\ l_j \geq l_i\} \quad (5)$$

$$C_H(greater\ than\ l_i) = \{l_j | l_j \in L\ and\ l_j > l_i\} \quad (6)$$

$$C_H(between\ l_i\ and\ l_j) = \{l_k | l_k \in L\ and\ l_i \leq l_k \leq l_j\} \quad (7)$$

Let $env(HFLTS_S)$ be the envelope of $HFLTS_s$, it can be defined as in Eq. (8).

$$env(HFLTS_S) = [env(HFLTS_{S-}), env(HFLTS_{S+})], \quad HFLTS_{S-} \leq HFLTS_{S+} \quad (8)$$

where,

$$HFLTS_{S-} = \min(l_i) = l_j, \quad l_i \in HFLTS_S\ and\ l_i \geq l_j \forall i \quad (9)$$

$$HFLTS_{S+} = \max(l_i) = l_j, \quad l_i \in HFLTS_S\ and\ l_i \leq l_j \forall i \quad (10)$$

4.2 Hesitant Fuzzy AHP Methodology

The steps of the hesitant fuzzy AHP can be given as follows.

Step 1. Define the social innovation project risk hierarchy by using expert opinions and the literature review process.

Step 2. Create pairwise comparison matrices for social innovation project risks and obtain expert evaluations using the linguistic terms given in Table 1 [61].

Table 1. Linguistic Term Scale

Linguistic Term	Abb.	l_i	Triangular Fuzzy Number
Absolutely High Importance	(AHI)	l_{10}	(7,9,9)
Very High Importance	(VHI)	l_9	(5,7,9)
Essentially High Importance	(ESHI)	l_8	(3,5,7)
Weakly High Importance	(WHI)	l_7	(1,3,5)
Equally High Importance	(EHI)	l_6	(1,1,3)
Exactly Low Importance	(EE)	l_5	(1,1,1)
Equally Low Importance	(ELI)	l_4	(0.33,1,1)
Weakly Low Importance	(WLI)	l_3	(0.2,0.33,1)
Essentially Low Importance	(ESLI)	l_2	(0.14,0.2,0.33)
Very Low Importance	(VLI)	l_1	(0.11,0.14,0.2)
Absolutely Low Importance	(ALI)	l_0	(0.11,0.11,0.14)

Source: Created by the authors.

Step 3. Obtain a fuzzy envelope by aggregating HFLTS via OWA [62]. Sort the linguistic evaluations from lowest l_o to highest l_10. Let the experts' evaluation vary between two terms i.e. l_i and l_j, then $l_0 \leq l_i < l_j \leq l_g$. We can obtain the elements of aggregated trapezoidal fuzzy membership function $\widetilde{T} = (t_1, t_2, t_3, t_4)$ are computed as follows:

$$t_1 = \min\{l_L^i, l_M^i, l_M^{i+1}, \ldots\ldots l_M^j, l_R^j\} \quad (11)$$

$$t_4 = \max\{l_L^i, l_M^i, l_M^{i+1}, \ldots\ldots l_M^j, l_R^j\} \quad (12)$$

$$t_2 = \begin{cases} l_M^i \ , & if\ i+1=j \\ OWA_{w^2}\left(l_M^i, \ldots . l_M^{\frac{i+j}{2}}\right), & if\ i+j\ is\ even \\ OWA_{w^2}\left(l_M^i, .. l_M^{\frac{i+j-1}{2}}\right), & if\ i+j\ is\ odd \end{cases} \quad (13)$$

$$t_3 = \begin{cases} l_M^{i+1} \ , & if\ i+1=j \\ OWA_{w^1}\left(l_M^j, l_M^{j-1} .. l_M^{\frac{i+j}{2}}\right), & if\ i+j\ is\ even \\ OWA_{w^1}\left(l_M^j, l_M^{j-1}, .. l_M^{\frac{i+j+1}{2}}\right), & if\ i+j\ is\ odd \end{cases} \quad (14)$$

The weighting vectors in the OWA operation can be given as in Eq. (14-15) [63].

$W^1 = (w_1^1, w_2^1 \ldots w_n^1)$ can be defined as:

$$w_1^1 = \alpha_2, w_2^1 = \alpha_2(1-\alpha_2), \ldots\ldots w_n^1 = \alpha_2(1-\alpha_2)^{n-2} \quad (15)$$

The second type of weights $W^2 = (w_1^2, w_2^2 \ldots w_n^2)$ is defined as:

$$w_1^2 = {\alpha_1}^{n-1}, w_2^2 = (1-\alpha_1){\alpha_1}^{n-2}, \ldots\ldots w_n^2 = 1-\alpha_1, \quad (16)$$

where $\alpha_1 = \frac{g-(j-i)}{g-1}$ and $\alpha_2 = \frac{(j-i)-1}{g-1}$ j is the rank of highest evaluation and i is the rank of lowest evaluation value.

Step 4: Create the aggregated pairwise comparison matrix $\widetilde{CM}$ by using the values obtained in Step 3.

$$\widetilde{CM} = \begin{vmatrix} 1 & \tilde{t}_{12} \cdots \tilde{t}_{1n} \\ \tilde{t}_{21} & 1 \ \cdots \tilde{t}_{2n} \\ \vdots & \vdots \ \vdots \ \vdots \\ \tilde{t}_{n1} \tilde{t}_{n2} \cdots & 1 \end{vmatrix} \quad (17)$$

where $\tilde{t}_{ij} = (t_{ij_l}, t_{ij_{m1}}, t_{ij_{m2}}, t_{ij_u})$. The reciprocal values of this matrix satisfy the condition in Eq. (18).

$$\tilde{t}_{ji} = \left(\frac{1}{t_{ij_u}}, \frac{1}{t_{ij_{m2}}}, \frac{1}{t_{ij_{m1}}}, \frac{1}{t_{ij_l}}\right) \quad (18)$$

Step 5. Calculate the fuzzy geometric mean for each row ($\tilde{r}_i$) of the matrix $\widetilde{CM}$.

$$\tilde{r}_i = (\tilde{t}_{i1} \otimes \tilde{t}_{i2} \ldots \otimes \tilde{t}_{in})^{\frac{1}{n}} \quad (19)$$

Step 6. The fuzzy weight of social innovation risk is calculated via Eq. (19).

$$\widetilde{w}_i^{SIR} = \tilde{r}_i \otimes (\tilde{r}_1 \oplus \tilde{r}_2 \ldots \oplus \tilde{r}_n)^{-1} \quad (20)$$

Absolutely High Importance evaluation parameters are used to represent $\tilde{r}_1 \oplus \tilde{r}_2 \ldots \oplus \tilde{r}_n$ summation operation.

Step 7. Apply this step for every hierarchy level and calculate the global weights of the social innovation risk sub-criteria using Eq.(24).

$$\widetilde{w}_{ij}^{SIR} = \widetilde{w}_i^{SIR} \times \widetilde{w}_{ij}^{SIR} \quad (21)$$

where $\widetilde{w}_{ij}^{SIR}$ is the global weight of social innovation risk sub-criteria ij.

Step 8: Defuzzify the obtained fuzzy numbers $\widetilde{w}_{ij}^{SIR}$ using Eq. 21 and normalize the defuzzified values using Eq. (22).

$$w_{ij}^{SIR} = \frac{t_1 + 2*t_2 + 2*t_3 + t_4}{6} \quad (22)$$

$$w_{ij}^{SIR} = \frac{w_{ij}^{SIR}}{\sum_i \sum_j w_{ij}^{SIR}} \quad (23)$$

5 Application

In this study, three experts with academic backgrounds evaluate the social innovation project risks using hesitant fuzzy linguistic term sets. With this approach, the decision-makers could use linguistic expressions such as between very low important to high important. Table 2 shows the pairwise comparisons of the main risk criteria with respect to the goal, prioritizing the risks in social innovation projects.

Table 2. Pairwise comparisons of the main CRs with respect to the goal

Risks	*Market*	*Organizational.*	*Environmental*
Market	EE	Between ELI and EHI	Between EE and WHI
Organizational		EE	Between ESHI and AHI
Environmental			EE

Source: Created by the authors.

Table 3, Table 4 and Table 5 present the sub-risks' pairwise comparisons with respect to the main risks Market risks, Organizational Risks, and Environmental Risks.

Table 3. Pairwise comparisons of the sub-risks with respect to *Market Risks*

Risks	*Financial*	*Health and safety*	*Negative publicity*
Financial	EE	Between WHI and VSHI	Between VSHI and AHI
Health and safety		EE	Between ELI and EHI
Negative publicity			EE

Source: Created by the authors.

Table 4. Pairwise comparisons of the sub-risks with respect to *Organizational Risks*

	Supply chain	*Human resources*	*Production*	*Partner*	*Managerial*
Supply chain	EE	Between ELI and EE	Between WLI and EE	Between EHI and WHI	Between ELI and EHI
Human res.		EE	Between ELI and EE	Between EE and WHI	Between ELI and EE
Production			EE	Between ESHI and AHI	Between EE and EHI
Partner				EE	Between ELI and EE
Managerial					EE

Source: Created by the authors.

Table 5. Pairwise comparisons of the sub-risks with respect to *Environmental Risks*

Risks	*Competitive product*	*Legal and law-maker related*	*Cultural*
Competitive product	EE	Between WLI and EE	Between EE and WHI
Legal and lawmaker-related		EE	Between ESHI and AHI
Cultural			EE

Source: Created by the authors.

Applying hesitant AHP steps, we obtain the triangular fuzzy pairwise comparison matrix, geometric means, and the normalized weights given in Table 6.

Table 6. Pairwise comparison values and normalized weights of the main risks in social innovation projects

Risks	*Market*	*Organizational*	*Environmental*	*Normalized weights*
Market	(1,1,1,1)	(0.333,1,1,3)	(1,1,1,5)	(0.11,0.29,0.29,1.25)
Organizational	(0.333,1,1,3)	(1,1,1,1)	(3,6.778,7.22,9)	(0.16,0.55,0.57,1.52)
Environmental	(0.2,1,1,1)	(0.111,0.138,0.148,0.333)	(1,1,1,1)	(0.05,0.15,0.15,0.35)

Source: Created by the authors.

Steps 1-4 are repeated to obtain the weights of the sub-risks in social innovation projects and the weights of sub-risks are defined as in Table 7.

Table 7. Weights of the sub-risks in social innovation projects

	Defuzzified	**Normalized**
Market Risks		
Financial risks	0.532	0.247
Health and safety risks	0.153	0.071
Negative publicity risks	0.097	0.045
Organizational Risks		
Supply chain r.	0.215	0.1
Human resources r.	0.206	0.096
Production r.	0.366	0.17
Partner r.	0.107	0.05
Managerial r.	0.223	0.103
Environmental Risks		
Competitive product risks	0.074	0.034
Legal and law maker related risks	0.149	0.069
Cultural risks	0.033	0.015

Source: Created by the authors.

According to the results organizational risks have the highest impact on the success of social innovation projects. Nevertheless, among the sub-risks financial risks are very important. In the social innovation projects, in order to minimize the risks first, the financial risks should be eliminated. The second critical risk is the production risk. While producing a product or a service, the risks that can jeopardize the creation process will directly impact the success of social innovation projects.

6 Conclusion

Social innovations include novel applications that aim to meet social needs in a better way than the existing solutions [13] . There can be various social innovation projects which focus on social objectives, social interaction between actors, or actor diversity, social outputs, and innovativeness. Risk management, which is defined as the identification, prioritization, and evaluation of risks

associated with a project, is very important in social innovation projects [3].

In this paper, we focus on the prioritization of social innovation project risks by modeling the problem as a multi-criteria decision-making problem. We use Hesitant Analytic Hierarchy Process technique to prioritize the project risks. A decision model is constructed involving 3 criteria and 11 subcriteria.

For further research, we suggest the other extensions to be integrated by AHP method such as hesitant fuzzy linguistic term sets, fuzzy inference system, Pythagorean fuzzy sets, picture fuzzy sets, spherical fuzzy sets, or q-rung orthopair fuzzy sets in order to prioritize social innovation project risks. Other fuzzy multicriteria decision models using axiomatic design can be used. Their results can be compared with this work.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the author(s) utilized artificial intelligence (AI) technologies solely for the purpose of linguistic refinement and grammatical correction. Following the application of these tools, the author(s) comprehensively reviewed, verified, and edited the resulting text. The author(s) maintain full accountability and responsibility for the accuracy, integrity, and final content of the publication.

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