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ORIGINAL PAPER

A DECISION MAKING SUPPORT SYSTEM IN LOGISTICS COOPERATION USING A MODIFIED VIKOR METHOD UNDER AN INTUITUINISTIC FUZZY ENVIRONMENT

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ABSTRACT. **Background:** This paper proposes a novel hybrid group decision making methodology to solve a coalition-formation problem for cooperative replenishment with multiple firms to achieve operational efficiency. We consider a case of horizontal cooperation between firms, and we investigate the profitability of horizontal cooperation when designing collaborative contracts.
Methods: This study presents the application of a hybrid approach for group decision support for the coalition -formation problem. Multi-criteria decision making (MCDM) and intuitionistic fuzzy set (IFS) theory have been integrated to provide group decision support under consensus achievement. In addition, this study employs the entropy method to identify the weights of the decision makers.
Results: The proposed integrated approach has been further studied through an illustrative example. The decision procedure used here is simply structured so that it may easily be implemented with a computer.
Conclusions: This research may be beneficial to decision makers, researchers and organizations in helping them to understand project based evaluation in order to design and plan better horizontal cooperation.

Key words: Coalition formation, logistics cooperation multi-criteria decision analysis, group decision making, Shapley value, VIKOR.

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INTRODUCTION

Horizontal logistics collaboration offers a great opportunity for companies to reduce their distribution costs. By forming a coalition, companies have the potential to become more profitable. However, the selection of a coalition structure is a difficult task for decision makers. The decision maker needs to identify and choose the best possible partner(s) in order to carry out a joint plan with respect to many criteria. The aim of this paper is to propose a novel hybrid group decision making methodology to solve coalition-formation problem.

Drivers of horizontal collaboration and multi - criteria analyses in a coalition structure are studied in the literature, and may be categorized into four main groups according to their objectives as follows:

– **Cost reduction**. Horizontal cooperation reduces the costs of non-core activities, e.g. organizing safety training, joint fuelling facilities [Cruijssen et al. 2007]. Moreover, horizontal cooperation reduces purchasing costs, e.g. vehicles, onboard computers, fuel [Cruijssen et al. 2007].

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- **Service improvement**. Collaborative relationships improve the quality of the service provided at lower costs, e.g. in terms of speed, frequency of deliveries, geographical coverage, reliability of delivery times [Cruijssen et al. 2007, Ghaderi et al. 2016].
- **Market position**. Alliances are a useful tool with which to expand the available fleet, along with its service range and geographic coverage, and, as a result, to increase their customer reach [Gou et al. 2014].
- **Emission reduction**. Among the main motivating factors for companies to engage in a horizontal logistics coalition is the achievement of a higher degree of sustainability e.g. reduced emission of greenhouse gases and other undesirable substances [Soysal et al. 2018].

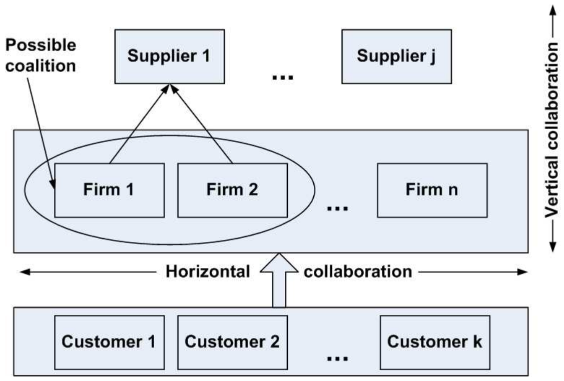
As a result of the aforementioned drivers of collaboration, firms attempted to join their orders by forming alliances. In order to contract coalition structure and prevent conflict situations in future coalitions, we address the following research issues:

1. Which criteria to choose for collaboration partner evaluation?
2. How to generate criteria and alternative ratings? How to specify the weights of criteria and decision makers objectively?
3. Which multi-criteria method to choose for collaboration partner evaluation?

Multiple criteria decision making (MCDM) methods provide an effective means of assisting decision makers to choose the best alternative given multiple criteria. In MCDM problems, a group decision matrix is established by aggregating the individual evaluation of each decision maker (DM) with the aim of finding a group satisfactory solution that is most preferred by the DMs [Cali and Balaman 2019]. VIKOR is a well-known and widely-used multiple attribute decision making method. The major advantage of the VIKOR method is that it may be used to trade off the maximum group utility of the majority and the minimum individual regret of the opponent [Wan et al., 2013, Tavana et al., 2016].

The fuzzy sets theory introduced by Zadeh [1965] has been very successful in dealing with problems involving uncertainty. Zadeh [1965] and Zhao et al. [2015] proposed the concept of the hesitant fuzzy set (HFS), which permits its membership to have a set of possible values. Fuzzy set theory may be used to model imprecision in MCDM problems. Atanassov [1986] extended the HFS considering the nonmembership degree and hesitation degree as well as the membership degree and proposed IFS theory.

In this paper, we address the problem of coalition-formation for cooperative replenishment with multiple firms to achieve operational efficiency, as it is presented in Figure 1. The selection of the most suitable partner(s) with respect to numerous conflicting criteria becomes a more challenging and difficult problem. Our goal is to identify the best partner(s) or the alliance.



Source: Jouida et al., 2017

Fig. 1. The business context considering collaboration and coalition-formation

In order to adopt a reliable and practical decision making model, we propose a hybrid MCGDM approach based on the integration of the IFS and VIKOR method with the aid of the entropy method and Shapley value to evaluate the weights of DMs and criteria by utilizing linguistic variables.

The paper is organized as follows. In Section 2, we introduce the concept of IFSs ,fuzzy measures, the entropy method, and Shapley value. The conceptual framework of the adopted research methodology is described in Section 3. In Section 4 an illustrative example is given. Finally, we conclude and discuss the direction of future works in Section 5.

PRELIMINARIES

IFSs

Definition 1. *[Zhao et al. 2015]. Given a fixed set $X = \{x_1, x_2, \dots, x_n\}$, then a hesitant fuzzy set (HFS) on X is in terms of a function that when applied to X returns a set of* $[0,1]$.

For convenience, Wei [2012] completed the original HFS definition by including the HFS mathematical representation as follows:

$$A = \{< x,\ h_A(x) > | x \in X\}$$

where $h_A(x)$ is a set of some values in $[0,1]$, and denotes the possible membership degree of the element $x \in X$ to the set A. For the sake of simplicity, $h(x) = h_A(x)$ is called a hesitant fuzzy element (HFE).

Definition 2. *[Atanassov 1986]. Given a fixed set $X = \{x_1, x_2, \dots, x_n\}$ then an IFS A in X is represented as*

$$A = \{< x,\ \mu_A(x), v_A(x) \quad > | x \in X\}$$

where the functions $\mu_A(x): X \to [0,1]$ represent the membership degree and non-membership degree of the element $x \in X$ to A subset of X and for every $x \in X$ in the following condition:

$$0 \le \mu_A(x) + v_A(x) \le 1.$$

In this paper, the hesitant normalized Hamming distance is used to measure the difference between the evaluation values of the alternatives. This measurement is defined as follows.

Definition 3. *[Zhang and Wei 2013]. Let h_1 and h_2 be two HFEs on $X = \{x_1, x_2, \dots, x_n\}$ then the hesitant Normalized Hamming distance measurement between h_1 and h_2 is defined as follows:*

$$||h_1 - h_2|| = \frac{1}{l}\sum_{j=1}^{l} |h_{1\sigma(j)} - h_{2\sigma(j)}|,$$

where $l(h)$ indicates the number of elements in h, and is defined as the length of HFE.

Shapley value

Definition 4. *[Shapley and Shubik 1953] Let μ be a fuzzy measurement on the set $X = \{x_1, x_2, \dots, x_n\}$. The Shapley index for every $j \in X$ is defined by*

$$\varphi_j = \sum_{K \subset X \setminus x_j} \frac{(n-|K|-1)!|K|!}{n!} [\mu(K \cup \{x_j\}) - \mu(K)] \quad (1)$$

where n and K are the number of criteria in X and $|K|$ respectively.

The Shapley value of μ is the vector $\varphi(\mu) = [\varphi_1, \varphi_2, \dots, \varphi_n]$.

The Shapley value φ_j returns the average value of the contribution $x_j \in X$ alone in all coalitions. Thus, a basic property of the Shapley value is that $\varphi_1 + \varphi_2 + \dots + \varphi_n = 1$.

Linguistic variables

Linguistic variables are variables of values which are not numbers but words or, more generally, linguistic labels off fuzzy sets [Zadeh 1983]. In our study, the weights of DMs are obtained based on those variables which are shown in Table 1.

Table 1. Number of regular destinations and passenger traffic in 2013

Linguistic variables	Intuitionistic fuzzy numbers
Extremely good (EG)/ extremely high (EH)	(1.00; 0.00; 0.00)
Very very good (VVG)/ very very high (VVH)	(0.90; 0.10; 0.00)
Very good (VG)/ very high (VH)	(0.80; 0.10; 0.10)
Good (G)/ high (H)	(0.70; 0.20; 0.10)
Medium good (MG)/ medium high (MH)	(0.60; 0.30; 0.10)
Fair (F)/medium (M)	(0.50; 0.40; 0.10)
Medium bad (MB)/medium low (ML)	(0.40; 0.50; 0.10)
Bad (B)/low (L)	(0.25; 0.60; 0.15)
Very bad (VB)/very low (VL)	(0.10; 0.75; 0.15)
Very very bad (VVB)/very very low (VVL)	(0.10; 0.90; 0.00)

Entropy concept

The concept of entropy in information theory was firstly proposed by Shannon [1948] which presented an equation to measure the uncertainty in information based on probability theory. The formulation of IF-entropy is depicted in the following equation.

$$E(A) = -\frac{1}{nln2}\sum_{j=1}^{n}[\mu_A(x_i)ln\mu_A(x_i) + v_A(x_i)lnv_A(x_i) - (1-\pi_A(x_i))\ln(1-\pi_A(x_i)) - \pi_A(x_i)ln2], \quad (2)$$

Consider an MCGDM problem where $A = \{a_1, a_2, \ldots, a_m\}$ are the alternative sets to choose, $X = \{x_1, x_2, \ldots, x_n\}$ are the criteria set, h_{ij} is the rating of alternatives a_i $(i = 1,2,\ldots,m)$ with respect to criteria x_j $(j = 1,2,\ldots,n)$.

Alternative a_i is represented as an A-IFS of the following form:

$$a_i = \{\langle x_j, X_{ij} | x_j \in X\rangle\}$$

where $X_{ij} = (\mu_{ij}, v_{ij})$. X_{ij} defines the degrees of satisfaction and dissatisfaction of the *i*th alternative regarding to the *j*th criterion respectively denoted by μ_{ij}, and v_{ij}, where $0 \le \mu_{ij} + v_{ij} \le 1$, $\pi_{ij} = 1 - \mu_{ij} - v_{ij}$, $i = 1,2,\ldots,m$, $j = 1,2,\ldots,n$. π_{ij} is the hesitancy degree of the *i*th alternative regarding to *j*th criterion.

DECISION SUPPORT SYSTEM

This section presents a detailed description of the proposed decision system in logistics cooperation. Companies have a lack of efficient and effective systems to conduct horizontal cooperation. The proposed approach is easy to implement the algorithm, moreover it is practical and provides solutions with incomplete quantitative information. The proposed model was applied to a practical case in logistics industry.

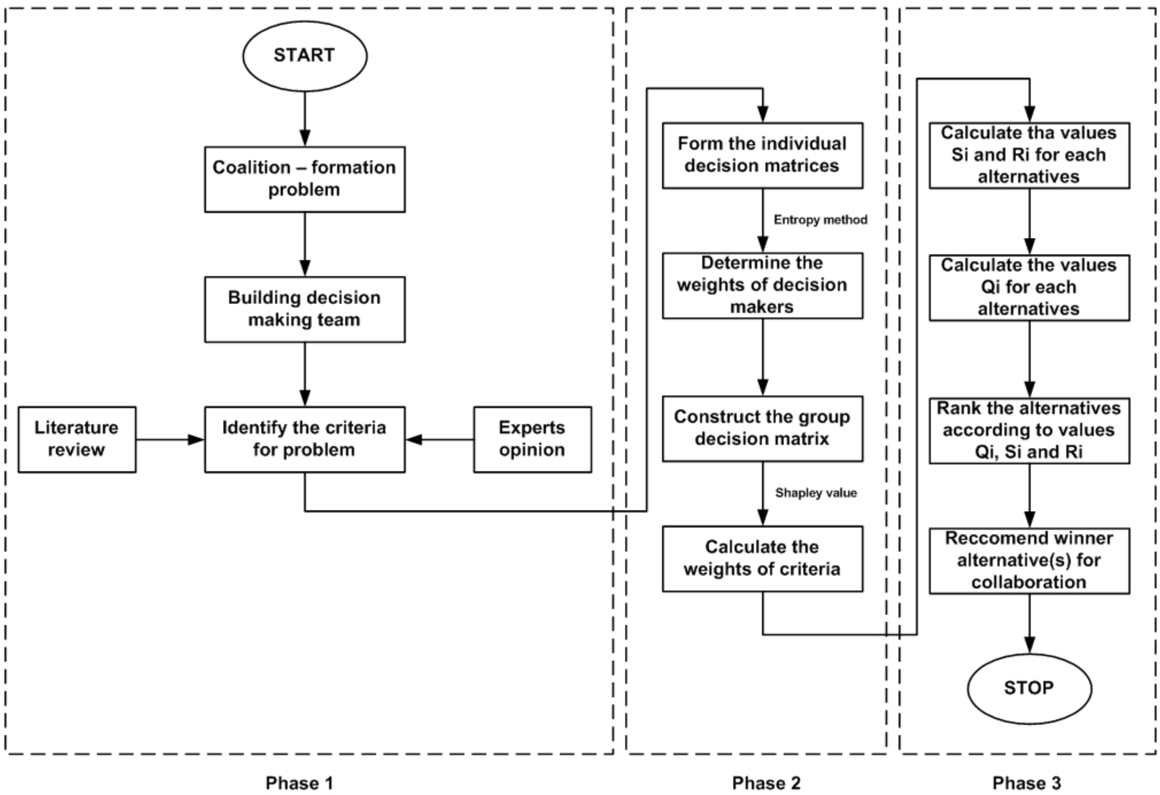


Fig. 2. Schematic diagram of the proposed model

In the proposed group decision model, the computational process takes place in three phases. Initially, the weights of the DMs and the weights of decision criteria are determined using the entropy method and Shapley value respectively. The second task is to generate the ranking of the logistics coalition-formation problem using fuzzy VIKOR. The suggested algorithm is presented in Figure 2 and explained subsequently.

Phase I

In this study, the criteria for coalition-formation problem were identified through literature review (Section 1) and validated by the company experts via nominal group technique for making an objective and unbiased decision [Delbecq et al. 1975].

Phase II

In the first step, assume that each expert provides his/her judgments on each factor as a linguistic term. Since linguistic terms are not mathematically operable, the next step is to make a standardization of expert evaluations by transforming them according Table 1. Therefore each individual decision matrix is formed according to evaluation of each DM. However, all DMs may not have the same weight in the decision process. The importance level of the experts is considered as linguistic terms. The weighted method used in this study is proposed by Calı and Balaman [2019]. The entropy of the kth DM is calculated as follows

$$E(R^{(k)}) = -\frac{1}{mnln2}\sum_{j=1}^{n}\sum_{i=1}^{m}[\mu_{ij}ln\mu_{ij} + v_{ij}lnv_{ij} - (1-\pi_{ij})\ln(1-\pi_{ij}) - \pi_{ij}ln2],$$

where $R^{(k)}$ indicates individual IF-decision matrix of E_k, $j = 1,2,\ldots,n$, $i = 1,2,\ldots,m$. Here if $\mu_{ij} = 0, v_{ij} = 0, \pi_{ij} = 1$,; then $\mu_{ij}ln\mu_{ij} = 0$, $v_{ij}lnv_{ij} = 0$, respectively.

Then, calculate the degree of divergence for each $R^{(k)}$ as following equation $d_{R^{(k)}} = 1 - E(R^{(k)})$. Finally, calculate the weights of DMs w_k using the following equation: $w_k = \frac{d_{R^{(k)}}}{\sum_{k=1}^{K} d_{R^{(k)}}}$. After the individual preferences are converted into priorities, these preferences of the group of decision makers are aggregated so as to estimate the collective preferences. The aggregation of the individual judgments are calculated by the equation

$$r_{ij} = \left[1 - \prod_{k=1}^{K}\left(1-\mu_{ij}^{(k)}\right)^{w_k}, \prod_{k=1}^{K}\left(v_{ij}^{(k)}\right)^{w_k}, \prod_{k=1}^{K}\left(1-\mu_{ij}^{(k)}\right)^{w_k} - \prod_{k=1}^{K}\left(v_{ij}^{(k)}\right)^{w_k}\right]. \quad (3)$$

As a result the group decision matrix $R = (r_{ij})_{m\times m}$ is constructed, where $r_{ij} = (\mu_{ij}, v_{ij}, \pi_{ij})$ indicates the evaluation value of ith alternative with reference to jth criterion according to group evaluation. The final step in this phase is to calculate the weights of criteria. The weights are obtained based on the Shapley value by applying equation (1).

Phase III

Once the weights of criteria are obtained, a modified VIKOR approach is proposed for conducting the ranking process. In order to determine the positive ideal solution (PIS) and the negative ideal solution (NIS): $A^+ = \{h_1^+, h_2^+, h_3^+, h_4^+\}$, $A^- = \{h_1^-, h_2^-, h_3^-, h_4^-\}$. The average score S_i and the worst group score R_i for each alternative are determined as follows:

$$S_i = \sum_{j=1}^{n}\varphi_j\frac{||h_j^+ - h_{1j}||}{||h_j^+ - h_j^-||}, \qquad R_i = \max_{x_j}\frac{||h_j^+ - h_{1j}||}{||h_j^+ - h_j^-||}\varphi_j$$

where φ_j are the weight of the separate criterion x_j contribution based on a different combination of sub-criteria and expressed by their relative importance in decision making. The best alternative to this method is determined on the basis of the overall ranking index Q_i by the following relationship:

$$Q_i = v\frac{S_i - S^*}{S^- - S^*} + (1-v)\frac{R_i - R^*}{R^- - R^*}$$

where S_i and R_i denote the average and the worst group score of alternative i, respectively,

$$S^* = \min_i S_i, \qquad S^- = \max_i S_i, R^* = \min_i R_i, \\ R^- = \max_i R_i$$

and υ represents the significance of the strategy, the value of which is usually set to 0.5.
Rank the alternatives by sorting the values S_i, R_i and Q_i in descending order. The larger the index value, the better the performance of the alternatives. The results are three ranking lists that may be used to propose and validate a compromise solution.

Obtain a compromise solution to the alternatives $A^{'}$, which is best ranked by the measure Q (minimum), if the following two conditions should be satisfied:

$\Delta 1$. Acceptable advantage $Q(A^{''}) - Q(A') \geq \frac{1}{m-1}$, where $A^{''}$ is the alternative with the second position in the ranking list by Q, and m is the number of alternatives.

$\Delta 2$. Acceptable stability in decision making the alternatives $A^{'}$ should also be the best ranked by S_i or/and R_i which indicates that this compromise solution is stable within a decision making process.

If the condition $\Delta 1$*:* is not satisfied, $A^{(M)}$ is determined by the relation $Q(A^M) - Q(A') \geq \frac{1}{m-1}$, for maximum M (the positions of these alternatives are "in closeness"). Thus, all alternatives $A^{'}, A^{''}, \dots, A^{(M)}$ are the compromise solutions. If the condition $\Delta 2$*:* is not satisfied, then both alternatives $A^{'}$ and $A^{''}$ are compromise solutions.

EXPERIMENTAL SETUP

Case background

A logistics company was chosen for the case study. The company was chosen due to their willingness to incorporate horizontal cooperation practices into their operations as well as their experience in the field. The company wishes to select the best coalition for logistics cooperation. After pre-assessment, a list of potential coalitions was identified for further assessment. To assess the best coalition structure, a panel consisting of three experts was formed. All of the of experts were chosen based on their reputation, performance, and also on the basis of their experience.

Coalition-structure selection based on extended VIKOR

Step 1. Determination of the goal, alternatives and criteria

The coalition in the example is any group of two or more companies that agree to work together temporarily in a partnership to achieve a common goal. It is further assumed that only one coalition may exist at any one time. Suppose there are three possible coalition structures a_i (i=1,2,3) to be evaluated. It is necessary to compare these coalition structures to select the most important of them from the point of view of their relative importance, taking into account the criteria suggested as drivers of horizontal collaboration: cost reduction (x_1); service improvement (x_2); market position (x_3); and emission reduction (x_4). Selection of these criteria were based on the reviewed literature (in Section 1), which were confirmed by DMs opinions.

Step 2. Construction of individual decision matrix

At the beginning of the evaluation process, each DM evaluated the alternatives with reference to each criterion using linguistic variables and afterward these ratings were converted to intuitionistic fuzzy numbers, presented in Table 2.

Table 2. The individual decision matrices with IFNs

		x_1	x_2	x_3	x_4
		$\mu\ v\ \pi$	$\mu\ v\ \pi$	$\mu\ v\ \pi$	$\mu\ v\ \pi$
$R^{(1)} =$	a_1	(0.7, 0.2, 0.1)	(0.8, 0.1, 0.1)	(0.8, 0.1, 0.1)	(0.7, 0.2, 0.1)
	a_2	(0.6, 0.3, 0.1)	(0.5, 0.4, 0.1)	(0.2, 0.3, 0.5)	(0.1, 0.75, 0.15)
	a_3	(0.1, 0.75, 0.15)	(0.25, 0.6, 0.15)	(0.4, 0.5, 0.1)	(0.5, 0.4, 0.1)
$R^{(2)} =$	a_1	(0.7, 0.2, 0.1)	(0.8, 0.1, 0.1)	(0.7, 0.2, 0.1)	(0.5,0.4, 0.1)
	a_2	(0.6, 0.3, 0.1)	(0.5, 0.4, 0.1)	(0.6, 0.3, 0.1)	(0.4, 0.5, 0.1)
	a_3	(0.5, 0.4, 0.1)	(0.7, 0.2, 0.1)	(0.8, 0.1, 0.1)	(0.6, 0.3, 0.1)
$R^{(3)} =$	a_1	(0.5, .4, 0.1)	(0.7, 0.2, 0.1)	(0.6, 0.3, 0.1)	(0.6, 0.3, 0.2)
	a_2	(0.4, 0.5, 0.1)	(0.5, 0.4, 0.1)	(0.7, 0.2, 0.1)	(0.4, 0.5, 0.1)
	a_3	(0.5, 0.4, 0.1)	(0.8, 0.1, 0.1)	(0.8, 0.1, 0.1)	(0.7, 0.2, 0.1)

Step 3. Expert weights calculation

To calculate the weights of the DMs, first entropy values was used based on equation. Then, the divergence values are specified using and finally, the weight of each DMs are obtained using equation. Table 3 shows the degree of importance of the DMs.

Table 3. The results of entropy method for weights of DMs

	DM1	DM2	DM3
Entropy values	0.128	0.082	0.120
Divergences	0.872	0.918	0.880
Weights	0.327	0.344	0.330

Step 4. Construction of the group decision matrix.

All individual evaluations are aggregated based on equation (3) as is shown in Table 4.

Table 4. The group decision matrices with IFNs

		x_1	x_2	x_3	x_4
		$\mu\ v\ \pi$	$\mu\ v\ \pi$	$\mu\ v\ \pi$	$\mu\ v\ \pi$
$R =$	a_1	(0.64, 0.25, 0.65)	(0.77, 0.13, 0.77)	(0.71, 0.18, 0.72)	(0.61, 0.29, 0.58)
	a_2	(0.54, 0.36, 0.54)	(0.50, 0.40, 0.50)	(0.54, 0.26, 0.48)	(0.32, 0.57, 0.31)
	a_3	(0.39, 0.49, 0.39)	(0.65, 0.23, 0.66)	(0.71, 0.17, 0.73)	(0.61, 0.29, 0.61)

Step 5. Prioritizing criteria

This step starts with determination of the criteria correlation. To accomplish this, each DM was provided with a questionnaire and was asked to estimate the importance of each factor. The fuzzy measure of criteria x_j $(j = 1, 2, 3, 4)$ of X is as follows:

$$\mu(\emptyset) = 0,$$

$$\mu(x_1) = 0.35, \mu(x_2) = 0.3, \mu(x_3) = 0.22, \mu(x_4) = 0.2,$$

$$\mu(x_1, x_2) = 0.7, \mu(x_1, x_3) = 0.65, \mu(x_1, x_4) = 0.62, \mu(x_2, x_3\ ) = 0.55, \quad \mu(x_2, x_4\ ) = 0.45, \mu(x_3, x_4\ ) = 0.4$$

$$\mu(x_1, x_2, x_3) = 0.82, \mu(x_1, x_2, x_4) = 0.79, \mu(x_1, x_3, x_4) = 0.7, \mu(x_2, x_3, x_4) = 0.65,$$

$$\mu(x_1, x_2, x_3, x_4) = 1.$$

Using equation (1), the Shapley value for criteria can be obtained as follows:

$$\varphi(x_1) = 0.355, \varphi(x_2) = 0.277, \varphi(x_3) = 0.203, \varphi(x_4) = 0.165.$$

Step 6. Calculate the values S_i and R_i for each alternatives

Determine the ideal and negative-ideal solution:

$$A^+ = \{h_1^+, h_2^+, h_3^+, h_4^+\} = \{0.65, 0.77, 0.73, 0.61\},$$

$$A^- = \{h_1^-, h_2^-, h_3^-, h_4^-\} = \{0.25, 0.13, 0.17, 0.29\}.$$

Next, we compute S_i and R_i as below:

$$S_1 = \sum_{j=1}^{4} \varphi_j \frac{||h_j^+ - h_{1j}||}{||h_j^+ - h_j^-||} = 0.344, S_2 = 0.499, S_3 = 0.437.$$

$$R_1 = \max_{x_j} \frac{||h_j^+ - h_{1j}||}{||h_j^+ - h_j^-||} \varphi_j = 0.119, R_2 = 0.150, R_3 = 0.199.$$

Step 7. Calculate the values Q_i for each alternatives

Let $v = 0.5$, we compute

$$Q_i\ (i = 1,2,3): Q_1 = 0.000, \quad Q_2 = 0.691, \quad Q_3 = 0.802.$$

Step 8. Rank the alternatives according to values Q_i, S_i and R_i.

The Q_i, S_i and R_i values are sorted in decreasing order and three different rankings are presented in Table 5. Coalition a_1 is in the first position of the ranking lists considering *S; R* and *Q* values. The condition given by 4 is tested

$$Q(a_2) - Q(a_1) = 0.691 > 0.5.$$

Therefore, the condition (4) of acceptable advantage is satisfied. Consequently, coalition a_1 is chosen as he most appropriate coalition partner(s) for the company according to the methodology developed.

Table 5. The ranking

	a_1	a_2	a_3	Ranking	Compromise solution
S	0.344	0.499	0.437	$a_1 < a_3 < a_2$	a_1
R	0.119	0.150	0.199	$a_1 < a_2 < a_3$	a_1
$Q(v = 0.5)$	0.000	0.691	0.802	$a_1 < a_2 < a_3$	a_1

CONCLUSIONS

Existing research concerning horizontal logistics cooperation has mainly focused on assessing costs and benefits and their allocation to individual collaborating partners [Defryn et al. 2019]. However, the main interest of the potential collaborating firms is to figure out how the collaborating groups should be formed [Jouida et al. 2017]. In order to response to this question, in this paper a general solution framework is presented for optimising decisions in a horizontal logistics cooperation. Specifying, we present an effective model using modified VIKOR techniques for evaluating the best coalition partner(s) in a logistics alliance in an intuitionistic environment. In order to accommodate the criteria, the Shapley value is selected to obtain the relative weight of criteria.

The coalition-formation concept fits well in the real-world case of collaborative transportation that motivated our research. Group decision-making concerning the selection of the coalition partner(s) may help managers to face the problems that directly affect the viability of their organization. This research may be beneficial to decision makers, researchers and organizations in helping them to understand project based evaluation in order to design and plan better horizontal cooperation. Further studies may include situations where the information is in the form of an interval-valued intuitionistic fuzzy number.

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SYSTEM WSPARCIA DECYZJI W WSPÓŁPRACY LOGISTYCZNEJ Z WYKORZYSTANIEM ZMODYFIKOWANEJ METODY VIKOR W ROZMYTYM ŚRODOWISKU

STRESZCZENIE. **Wstęp:** W artykule zaproponowano nową metodologię podejmowania decyzji dotyczących tworzenia koalicji między wieloma firmami w celu osiągnięcia wydajności operacyjnej. Rozważany jest przypadek horyzontalnej współpracy między firmami, a następnie badana jest opłacalność współpracy horyzontalnej przy projektowaniu umów o współpracę.

Metody: W pracy przedstawiono zastosowanie podejścia hybrydowego do wspomagania decyzji grupowych w przypadku problemu koalicji. Zintegrowano wielokryterialne podejmowanie decyzji (MCDM) i intuicyjną teorię zbiorów rozmytych (IFS), aby zapewnić grupowe wsparcie decyzji przy osiągnięciu konsensusu. Ponadto zastosowano metodę entropii do identyfikacji wag osób podejmujących decyzje.

Wyniki: Proponowane zintegrowane podejście zostało poddane dalszej analizie za pomocą przykładu. Zastosowana tutaj procedura decyzyjna ma prostą strukturę, dzięki czemu można ją łatwo wdrożyć za pomocą komputera.

Wnioski: Badania te mogą być korzystne dla decydentów, badaczy i organizacji, pomagając im zaprojektować i zaplanować współpracę horyzontalną.

Słowa kluczowe: tworzenie koalicji, współpraca logistyczna, analiza decyzji wielokryterialnych, grupowe podejmowanie decyzji, wartość Shapleya, VIKOR.

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