International Journal for Quality Research 12(4) 975–988
ISSN 1800-6450

Snezana Nestic [1]
Nikolina Ljepava
Aleksandar Aleksic

STAKEHOLDER MANAGEMENT IN REVERSE SUPPLY CHAINS - THE RANKING OF REVERSE SUPPLY CHAINS ENTITIES UPON REQUIREMENTS' FULFILLMENT

Article info:
Received 19.06.2018
Accepted 23.08.2018

UDC – 05.311
DOI – 10.18421/IJQR12.04-12

Abstract: *Stakeholder management encompasses different activities which have a significant impact on the project realization. Business practice indicates that before and during the project realization, an organization that implements the project, or even consortium of entities, should put much attention in to satisfy different stakeholders' requirements. The aim of this paper is ranking of reverse supply chain (RSC) entities upon key stakeholders requirements' fulfillment. In the first step of research, key stakeholders are identified through stakeholder management analysis. Their requirements are analyzed and weighted by using fuzzy Delphi method. The decision makers perform their assessment taking in account linguistic expressions, so they do not need to think about precise numbers. In this way, the process of decision making is made easier compared to the conventional approach. The determination of the RSC entities upon key stakeholders requirements' fulfillment is performed by using the fuzzy ELECTRE method.*

Keywords: *Decision Sciences, reverse supply chains, fuzzy sets, fuzzy group decision making, ELECTRE*

1. Introduction

Changes in the business environment lead to increased competition in the global market which may result in an increased use of resources and cause various problems in the area of sustainable development. Organizations worldwide are facing a variety of challenges to fulfil customer demands and the needs of its stakeholders. The significant number of organizations are trying to implement 5R (Refuse Reduce Reuse Repurpose Recycle) principle, especially in RSC. The trends in developed countries indicate that the flows of electrical and electronic equipment (EEE) and the corresponding waste (WEEE) are analyzed and managed in detail, e.g., in Denmark (Parajuly et al., 2017). On the other hand, management of WEEE in developing countries brings numerous open issues, such as performance management (Neely et al., 1995, Nudurupati et al., 2012) or stakeholder management (Lehtinen, 2018).

The motivation for this research is represented by the fact that many stakeholders may have their interest in RSC entities and their projects. While performing an analysis of entities, it may be assumed that the dominant role is dedicated to the recycling centers (RC) in this case which should implement a new project related to recycling of EEE. WEEE product categories with targets of the EU WEEE Directive

[1] Corresponding author: Snezana Nestic
Email: s.nestic@kg.ac.rs

2012/19/EU could be categorized as follows: (1) Temperature exchange equipment, (2) Screens, monitors, equip. with surface screens >100 cm2, (3) Lamps, (4) Large equipment, (5) Small equipment and (6) Small IT and telecommunication equipment.

During the period of project realization, many risks may occur (Aleksic et al., 2017, Stefanović et al., 2015). Successful practice and literature review indicate that success factors of project delivery embrace six categories (Doherty, 2011): Strong commitment and support of senior management, clearly stated and measurable objectives and tasks, interpersonal and managerial skills of the project manager, skills and expertise of the project team, detailed and realistic timetable of the project, clear, unequivocal and feasible requirements of the project. In compliance with this, it may be considered that the success of the project itself is relied on key stakeholders (key players). Managing key stakeholders involves recognizing and taking into account the various interests and values that key stakeholders have and their resolution during the project's duration.

The goal of the research is achieved through 1) identification of key stakeholders in the scope of electrical and electronic equipment recycling project through the stakeholder analysis, 2) the assessment of relative importance of key stakeholders' requirements by using fuzzy Delphi method, (3) the ranking of RSC entities with respect to all requirements and their weighs by using ELECTRE (ELimination Et Choix Traduisant la REalité (ELimination and Choice Expressing REality)) method (Roy, 1968).

While analyzing the requirements that should be fulfilled, it may be noticed that some of them are more important, or in other words, their weight is greater. For the purpose of this research, the Delphi method (Dalkey & Helmer, 1963) is used. This method is based on the principle that decisions from a structured group of experts are more accurate compared to the groups of regular people or unstructured groups. The initial contributions from the expert team (structured group) should be collected in the form of questionnaire responses. Additionally, the expert team could have an option to add the open-ended comments to the questionnaire responses.

During the project implementation, different entities within the consortium, in this case, RSC entities, may interact and conduct project activities. The ranking of the identified RSC entities, various methods for Multiple-criteria decision-making (MCDM) could be employed. Solving MCDM problems may be conducted in different ways; for this purpose, the French school proposes methods named ELECTRE. This approach is widely used in the literature (Figueira et al., 2013). Sometimes the relative importance of criteria (their weight) is not measurable, and precise numbers cannot describe their values. This shortcoming may be overcome by applying fuzzy sets theory.

Changes in the environment are happening fast and continuously, so that estimation of all uncertainties which exists in the considered problem cannot be described by crisp values. Closer to the human thinking is to use linguistic variables (Zadeh, 1975) instead of numerical values. In literature, there are many mathematical approaches by which linguistic variables are quantified in a sufficiently good way. In this paper, all current uncertainties are modeled by using the fuzzy sets theory (Klir & Folger, 1988; Zimmermann, 2001) due to the fact that it has been widely used for modelling uncertainties of any kind.

The paper is organized as follows: Section 2 provides a literature review and theoretical background. Section 3 explains the evaluation framework, and section 4 clarifies the modeling of uncertainties which exists in the proposed model. The modified ELECTRE is presented in section 5 and illustrative example of the modified ELECTRE in RSC with respects to critical stakeholders' requirements is given in section 6. Section 7 sets the conclusion of the research.

2. Literature review

Cooperation with stakeholders has become a cornerstone of the modern business. Focus on external stakeholder participation in value-creating and decision-making activities in business activities in different contexts, including supply chain management (Mackelprang et al., 2014) and quality management (Arsovski et al., 2009), is increasing. The external stakeholder engagement should be managed because it can be crucial for enterprise performance and long-term sustainability.

An accepted definition of stakeholders in a business context include "any group or individual who can influence or be affected by the achievement of the organization's goals" (Freeman, 1984). Managing key stakeholders is planned and iteratively throughout the entire life cycle of the project. It includes (PMI, 2017): (1) identification of key stakeholders and analysis of their expectations and impact on the project, (2) planning of stakeholder engagement: developing an appropriate management strategy for effective stakeholders inclusion in the decision-making and execution of project activities, (3) managing of execution: communication, working with key stakeholders, problem-solving, (4) control: feedback and strategy adjustment. The identification of key stakeholders, an analysis of their expectations and impact the on the project are closely interconnected (Aragonés-Beltrán et al., 2017). This issue is crucial considering the possible pressures of the stakeholders and the effect of their strategies to the project outcomes (Aaltonen & Sivonen, 2009). The mapping of stakeholders is a way of determining a list of key stakeholders and their positive or negative impact. The most common technique for this analysis is Mendelow's Power-Interest Matrix. This technique is used to analyze the power/influence vs. interest/importance of stakeholders. For each identified stakeholder, an analysis of power and interest is conducted and mapped their multiple stakes (Ginige et al., 2018). The stakeholders mapping is a particularly useful technique which provides a detailed understanding of who has a stake and why and to assess the stakes of various interested players in an RC.

After the key players are identified, their requirements are supposed to be the subject of the analysis. The management team should assess their requirements with a goal to rank them. After that, appropriate actions may be defined during successful project implementation. During the ranking process, it may be noticed that ranking criteria often do not have the same weight. The determination of the criteria weight, in this case, requirement weight, may be determined by using fuzzy Delphi method (Kuo & Chen, 2008). According to the referent literature (Kaya & Kahraman, 2011; Tadić et al., 2015), it is more likely that a fuzzy rating of the relative importance of requirements should be stated as a fuzzy group decision-making problem. Fuzzy rating of the relative importance of requirements was performed in a direct way (Nestic et al. 2015). In general, the consensus could be obtained by using different operators. In this paper, aggregation individual opinions of decision-makers are given by using fuzzy Delphi method.

By applying the method for comparison of fuzzy numbers (Dubois & Prade, 1979; Baas & Kwakernaak, 1977), the weights vector of requirements is obtained. The normalized weight vectors are not fuzzy numbers (Bozbura et al., 2007). The uncertain requirement values are assessed by of RSC management team who use pre-defined linguistic terms which are modeled by TFNs, in similarity to the papers (Kaya & Kahraman, 2011; Tadić et al., 2015; Paksoy et al., 2012). In the considered problem, requirements are benefit and cost type. It is necessary to carry out normalization of assessed requirement values with respect to the requirement type. All uncertain requirement values are modeled by TFNs and normalized by the linear normalization method presented in Shih et al., (2007) analog to Tadic et al., (2015). The fuzzy decision matrix is then constructed. The elements of this matrix are calculated as product weight requirement and their normalized value. The weighted normalized value of requirement is described by TFNs according to fuzzy rules algebra (Zimmermann, 2001). The most widely used methods defuzzification are moment method and method of maximum possibility, used in this paper. In this way, the decision matrix whose elements are crisp will be obtained. Ranking of considered recycling centers using conventional ELECTRE method.

The problem of ranking entities, performances or indicators may be solved by applying the ELECTRE method (Augusto et al., 2008; Amiri et al., 2008). Besides ELECTRE, other methods may be employed, such as fuzzy TOPSIS and DEA (Zeydan et al. 2011; Saranga & Moser, 2010), or genetic algorithm (Nestić et al., 2015). It is worth to mention that similar problems may be treated by deploying AHP or ANP methods (Wu et al., 2006; Yüksel & Dağdeviren, 2010). This research proposes modified ELECTRE III since a variety of key performance indicators are analyzed, and the significant number of them has been distinguished for the proposed model. Since the number of treated key performance indicators is relatively high, ELECTRE method shows an advantage over AHP. ELECTRE method embraces less subjective thinking. In the same time, it demands slightly fewer experts' knowledge during the process of decision making and an assessment. Compared to AHP, ELECTRE demands narrower the scope of calculation because of Saaty's assumption. This assumption is related to possible mistakes during the decision-making process so the consistency check of the defined matrix should be delivered. It may be assumed that the higher the number of assessed alternatives increases the possibility to make a mistake. Taking into consideration the proposed advantages for the specific research proposed in this paper, the method ELECTRE has been chosen for the purpose of ranking.

3. Evaluation framework

In respect to identified requirements and their weights, ranking recycling centers with respects to key stakeholders requirements' fulfillment may be consisted of next steps as summarized in figure 1.

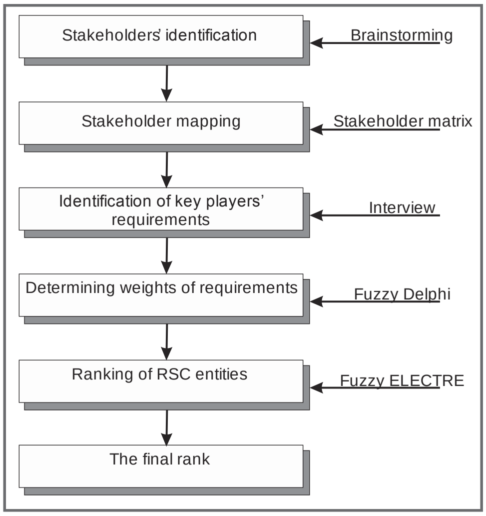

Figure 1. Flow chart of the proposed model

Step 1. The RSC may consist of a large number of interconnected entities. The considered RSCs are given by a set of indices $\pi = \{1, \ldots, p, \ldots, P\}$. The total number of entities is denoted as P and p is an index of RSC entity p, p=1,..,P. It is common to assume that the implementation of each new project implies the need for stakeholders management. At the beginning, it is important to identify all relevant stakeholders.

Step 2. The identified stakeholders should be assessed in terms of their interest and power.

Step 3. After determining the key players, their main demands are identified and elaborated on.

Step 4. The effectiveness of each RSC entity may be analyzed from the perspective of key stakeholders requirements' fulfillment. In the literature and practice, there are no international consensuses or standard definition of a unique list of requirements of any stakeholder including state or government. Formally, requirements of key stakeholders can be presented by set indices $\kappa = \{1, \dots, k, \dots, K\}$. The index for a requirement is denoted as k, k=1,..,K and K is the total number of identified requirements.

Step 5. The requirements values are given based on an assessment of the RSC management team which form an opinion by consensus. These values are described by pre-defined linguistic variables which are modeled by TFNs.

Step 6. The fuzzy decision matrix is constructed. The value of each element of the fuzzy decision matrix is calculated as the multiplication of the weight and normalized value of considered requirement.

Step 7. The final rank of the RSC entities can be obtained by applying the proposed ELECTRE method. Priority management actions should be determined with respect to the acquired rank.

4. Modeling of uncertainties

Uncertainties into the relative importance of requirements and their values are described by the linguistic variables which are modeled by TFNs (Zimmermann, 2001). The parameters of a membership function shape, granularity, and location in the universe of discourse are determined by decision makers. Their assessments are based on experience, knowledge, etc.

It may be noticed that the triangular membership function describes uncertainties well enough, and in the same time, its use does not require sophisticated mathematical calculations. Generally, numbers of linguistic variables which are assigned to the existing uncertainties depend on the type and size of the problem. In the considered problem, seven different linguistic variables are used. The domains of defined TFNs are defined as common scale measurement (Saaty, 1991), by analogy many papers (Kaya & Kahraman, 2011). There is no guideline how to determine lower bound, upper bound and modal value of any TFN. TFNs may be presented symmetrically on the proposed scale, or they may be given in compliance with decision makers' experience and knowledge.

4.1. Modeling of relative importance and values

In practice, the relative importance of requirements and their values in RSC entities are assessed by using the results of benchmarking, experience, etc. The fuzzy rating of relative importance of requirements can be introduced as TFNs $\left(x; l_k^e, m_k^e, u_k^e\right)$ with the lower and upper bounds l_k^e, u_k^e and modal values m_k^e, respectively. The domains of these TFNs are defined to a real set into the interval [1-9]. Value 1, and 9 denote that relative importance of requirement k, k=1,..,K is at the lowest value, and the highest value, respectively. The assessment of requirements values is based on knowledge and experience of decision makers of RSC entities. These values are described by linguistic variables which are further presented.

Specifically, seven linguistic expressions are used in this case. These linguistic expressions are modeled by TFNs as follows:

very low importance/value (VL)- $(x;1,1,5.5)$

low importance/value (L)- $(x;1,3,5)$

medium-low importance/value (ML)- $(x;2,4,6)$

medium importance/value (M)- $(x;3,5,7)$

medium-high importance/value (MH) - $(x;4,6,8)$

high importance (H)/value- $(x;5,7,9)$

very high importance (VH)/value- $(x;4.5,9,9)$

4.2. The proposed fuzzy Delphi method

In the Fuzzy Delphi Method as a direct prediction method, the decision makers do not know how many experts are involved. These assumptions are fundamental in preventing them from environmental influence, and they encourage objectivity. In the first step, decision makers, assess the relative importance of each requirement by using seven pre-defined linguistic variables. It is assumed that all members of the management team have equal relative importance aggregated value of assessment can be determined by the fuzzy averaging method. According to fuzzy algebra rules (Klir & Folger, 1988; Zimmermann, 2001), this value is described by TFN, too. The distance between obtained aggregated value and pre-defined linguistic variables are calculated by applying procedure in (Sadeghpour-Gildeh & Gien, 2001). The obtained aggregated value joins to pre-defined linguistic variables which are associated with the minimum value of distance. This information is returned to decision makers in written form, and it can be relevant to decision makers make a new judgment. In a similar way, a new fuzzy rating of decision makers is treated. It can be considered that a consensus is achieved in the second iteration because in the decision-making process participate few decision makers.

The algorithm of the proposed fuzzy Delphi method is given:

Step 1. Fuzzy rating of the relative importance of requirement k, k=1,..,K is provided by each decision maker $\tilde{W}_k^e = \left(x; l_k^e, m_k^e, u_k^e\right)$, $k = 1,\ldots, K;\ e = 1,\ldots, E$

Step 2. The average value of fuzzy rating of decision makers $\tilde{W}_k = (x; l_k, m_k, u_k)$ is obtained by using fuzzy arithmetic rules,

where: $l_k = \frac{1}{E}\cdot\sum_{e=1}^{E} l_k^e$, $m_k = \frac{1}{E}\cdot\sum_{e=1}^{E} m_k^e$,

$$u_k = \frac{1}{E}\cdot\sum_{e=1}^{E} u_k^e,\ k = 1,\ldots K;\ e = 1,\ldots, E$$

Step 3. Distances between of TFN $\tilde{W}_k$ and TFN numbers which are modeled pre-defined linguistic variables are denoted, $d_n,\ n = 1,\ldots, 7$. It can be said that the aggregated value of the relative importance of requirement k, k=1,..,K can be described by linguistic variables which are associated with the lowest value of the distance $a_n,\ n = 1,\ldots, 7$.

Step 4. The average value of fuzzy rating of decision makers in the second iteration is calculated by applying the fuzzy averaging method.

5. The modified ELECTRE

The modified ELECTRE can be shown through the further steps.

Step 1. Calculate to the weights vector of requirements of key stakeholders by applying the procedure for comparison of fuzzy numbers (Dubois & Prade, 1979; Baas & Kwakernaak, 1977). The degree of the belief that requirement k, k=1,..,K has higher relative importance than all other requirements corresponds with a measure of belief according to which $\tilde{W}_k$ is bigger than all other TFNs $\tilde{W}_{k'}$, $(k, k' = 1,\ldots, K;\ k \neq k')$.

The weights vector is represented as:

$$W_p = \left(\left(Bel\left(\tilde{W}_1\right)\right),\ldots,\left(Bel\left(\tilde{W}_k\right)\right),\ldots,\left(Bel\left(\tilde{W}_K\right)\right)\right)$$

By normalization procedure, the normalized weights vector W is given as: $W = (w_1,\ldots, w_k,\ldots, w_K)$

W is a non-fuzzy number, and this gives the priority weights of one criterion over the other.

Step 2. Transformation of all linguistic criteria values, $\tilde{v}_{pk}$ whose domains are defined on a common scale [1-9] (Saaty, 1991) into $\tilde{r}_{pk}$ by applying the linear normalization method (Shih et al., 2007):

for a benefit type requirement:

$$\tilde{r}_{pk} = \left(\frac{l_{pk}}{u_k^*}, \frac{m_{pk}}{u_k^*}, \frac{u_{pk}}{u_k^*}\right)$$

for a cost-type requirement:

$$\tilde{r}_{pk} = \left(\frac{l_k^-}{u_{pk}}, \frac{l_k^-}{m_{pk}}, \frac{l_k^-}{l_{pk}} \right)$$

where: $u_k^* = \max_{p=1,..,P} d_{pk}$, $l_k^- = \min_{p=1,..,P} l_{pk}$

Step 3. Construct to the fuzzy decision matrix

$$\tilde{D} = \left[\tilde{d}_{pk} \right]_{PxK} = \left[w_k \cdot \tilde{r}_{pk} \right]_{PxK}$$

Step 4. Defuzzification of fuzzy decision matrix elements is performed by using the method of maximum possibilities, so that:

$$d_{pk} = \text{defuzz}\ (d_{pk}),\ p = 1,..,P;\ k = 1,..,K$$

Step 5. Determine concordance set $S_{pp'}$ and discordance set $NS_{pp'}, p, p' = 1,..,P;\ p \neq p'$: $S_{pp'} = \{k\}_{k=0,1,...,K}$ $NS_{pp'} = \{k\}_{k=0,1,...,K}$

Step 6. Determine concordance matrix C and discordance matrix N:

$$C = \left[c_{pp'} \right]_{PxP},$$

$$N = \left[n_{pp'} \right]_{PxP},\ p, p' = 1,..,P;\ p \neq p'$$

where: $c_{pp'}$ and $n_{pp'}$, $p, p' = 1,..,P;\ p \neq p'$ are not defined in the main diagonal

$c_{pp'} = 0$ and $n_{pp'} = 0$ if

$c_{pp'} \in S_{pp}$ and $n_{pp'} \in NS_{pp}$, respectively

$$c_{pp'} = \sum_{k;(p,p') \in S_{pp'}} w_k \text{ and}$$

$$n_{pp'} = \frac{\max_{k \in NS_{pp'}} \left\{ \left| d_{pk} - d_{p'k} \right| \right\}}{\max_{k=1,..,K} \left\{ \left| d_{pk} - d_{p'k} \right| \right\}}$$

Step 7. Determine the average concordance index $\bar{c}$ and the average discordance index $\bar{n}$

$$\bar{c} = \frac{1}{P \cdot (P-1)} \sum_{p=1}^{P} \sum_{p=1}^{P} c_{pp'} \text{ and}$$

$$\bar{n} = \frac{1}{P \cdot (P-1)} \sum_{p=1}^{P} \sum_{p=1}^{P} n_{pp'}$$

Step 8. Construct the concordance dominance matrix:

$$M = \left[m_{pp'} \right]_{PxP}$$

where:

$$m_{pp'} = 0 \text{ if } c_{pp'} < \bar{c} \vee n_{pp'} > \bar{n}$$

$$m_{pp'} = 1 \text{ if } c_{pp'} \geq \bar{c} \vee n_{pp'} \leq \bar{n}$$

Step 9. Rank to RSC entities according to the value M_p. These values are sorted into the growing order. RSC entities, which is associated with the lowest value M_p, is in the first place in the rank and the reverse is also true.

$$M_p = \sum_{k=1}^{K} m_{pp'}$$

6. Application and discussion of modified ELECTRE in RSC entities evaluation with respects to the requirements of key stakeholders

The developed model was tested on the data obtained from RSC and its entities which exist in central Serbia. The main requirements relevant to RSCs entities are derived from identified key stakeholders.

The identified key stakeholders are: the local government, the citizens living in the region, the NGOs operating in the region, the public communal company. The detailed analysis of the key stakeholders' requirements is performed by the RSC management team. The requirements of key stakeholders are classified to the seven groups of requirements which are used as criteria for assessment of the RSC entities preferences: legal requirements (k=1), requirements defined by EU directives (k=2), requirements related to decreasing air and water pollution in the region (k=3), requirements related to new job opportunities (k=4), requirements related to social responsibility (k=5), requirements related to decreasing garbage in the region (k=6), requirements associated with making better landscaping of the region (k=7).

The proposed procedure can be illustrated by determining the relative importance requirements – legal requirements (k=1). In the first iteration fuzzy rating of the relative importance of considered requirements is given: MH, VH, VH, H, MH, VH, M.

The average value of the fuzzy rating is $\tilde{W}_{11} = (4.21, 7.29, 8.43)$.

Distances between TFN $\tilde{W}_{11} = (4.21, 7.29, 8.43)$ and TFNs are:

$$d\left(M, \tilde{W}_{11}\right) = \sqrt{\frac{1}{3}\left[(3-4.21)^2 + (5-7.29)^2 + (7-8.43)^2\right]} = 1.708$$

$$d\left(MH, \tilde{W}_{11}\right) = \sqrt{\frac{1}{3}\left[(4-4.21)^2 + (6-7.29)^2 + (8-8.43)^2\right]} = 0.794$$

$$d\left(H, \tilde{W}_{11}\right) = \sqrt{\frac{1}{3}\left[(5-4.21)^2 + (7-7.29)^2 + (9-8.43)^2\right]} = 0.578$$

$$d\left(VH, \tilde{W}_{11}\right) = \sqrt{\frac{1}{3}\left[(4.5-4.21)^2 + (9-7.29)^2 + (9-8.43)^2\right]} = 1.054$$

The lowest value of the distance between $\tilde{W}_{11} = (4.21, 7.29, 8.43)$ and considered TFNs is 0.578. The aggregate relative importance of requirement (k=1) can be described by linguistic term high importance (H).

In the second iteration fuzzy rating of the relative importance of considered requirements is given: H, VH, VH, H, H, VH, MH.

The average value of the fuzzy rating is $\tilde{W}_1 = (4.62, 7.71, 8.86)$.

Similarity the relative importance of rest requirements are determined:

$\tilde{W}_2 = (3.21, 5.57, 7.29)$,

$\tilde{W}_3 = (4.28, 6.28, 8.28)$, $\tilde{W}_4 = (2, 4, 6)$,

$\tilde{W}_5 = (1.29, 3.29, 5.29)$,

$\tilde{W}_6 = (2.29, 4.29, 6.29)$ and

$\tilde{W}_7 = (1.71, 3.71, 5.71)$

By applying the proposed algorithm (Step 1) the weights vector is determined:

$W_p = (1, 0.555, 0.719, 0.271, 0.132, 0.328, 0.214)$

The normalized weights vector is:

$W = (0.311, 0.172, 0.223, 0.084, 0.041, 0.102, 0.066)$

The values of each requirement fulfillment are given in Table 2.

Table 2. The level of treated requirements fulfillment imposed by key stakeholders in RSC entities

RSC Entities	**The requirements of key stakeholders**						
	k=1	**k=2**	**k=3**	**k=4**	**k=5**	**k=6**	**k=7**
The greatest supplier of RC (p=1)	$\tilde{H}$	$\tilde{M}$	$M\tilde{H}$	$M\tilde{L}$	$V\tilde{H}$	$M\tilde{H}$	$V\tilde{H}$
The second greatest supplier of RC (p=2)	$M\tilde{H}$	$\tilde{L}$	$V\tilde{L}$	$V\tilde{L}$	$\tilde{M}$	$M\tilde{L}$	$\tilde{H}$
RC (p=3)	$M\tilde{L}$	$M\tilde{H}$	$\tilde{H}$	$M\tilde{H}$	$M\tilde{H}$	$V\tilde{H}$	$V\tilde{H}$
The greatest customer of RC (p=4)	$V\tilde{H}$	$V\tilde{H}$	$\tilde{H}$	$\tilde{M}$	$M\tilde{L}$	$V\tilde{H}$	$\tilde{H}$
The second greatest customer of RC (p=5)	$\tilde{H}$	$\tilde{L}$	$M\tilde{L}$	$M\tilde{H}$	$V\tilde{L}$	$\tilde{M}$	$V\tilde{H}$

By using the proposed algorithm (Step 2 to Step 4), the decision matrix is constructed and presented in Table 3.

Table 3. The decision matrix

RSC Entities	The requirements of key stakeholders						
	k=1	**k=2**	**k=3**	**k=4**	**k=5**	**k=6**	**k=7**
p=1	0.2426	0.0963	0.1494	0.0210	0.0410	0.0683	0.0660
p=2	0.2084	0.0568	0.0245	0.0840	0.0229	0.0449	0.0515
p=3	0.1368	0.1152	0.1739	0.0143	0.0275	0.1020	0.0660
p=4	0.3110	0.1720	0.1739	0.0168	0.0180	0.1020	0.0515
p=5	0.2426	0.0568	0.0981	0.0143	0.0135	0.0571	0.0660

By using proposed algorithm (Step 5 to Step 7) concordance matrix (C) and discordance matrix (N) are constructed and the average concordance index, $\bar{c}$, and the average discordance index, $\bar{n}$, are determined.

$$C = \begin{bmatrix} - & 0.084 & 0.497 & 0.808 & 0 \\ 0.915 & - & 0.604 & 0.808 & 0.702 \\ 0.436 & 0.395 & - & 0.567 & 0.311 \\ 0.191 & 0.125 & 0.107 & - & 0.066 \\ 0.622 & 0.125 & 0.538 & 0.933 & - \end{bmatrix},$$

$$N = \begin{bmatrix} - & 1 & 1 & 0.3038 & 1 \\ 0.5045 & - & 0.4793 & 0.4498 & 0.9470 \\ 0.3185 & 1 & - & 0.0832 & 0.7164 \\ 1 & 1 & 1 & - & 1 \\ 0 & 1 & 1 & 0.1259 & - \end{bmatrix},$$

$\bar{c} = 0.4417$ and $\bar{n} = 0.6964$

The concordance dominance matrix (M) is constructed by using the proposed algorithm (Step 8).

$$M = \begin{bmatrix} - & 0 & 0 & 1 & 0 \\ 1 & - & 1 & 1 & 0 \\ 0 & 0 & - & 1 & 0 \\ 0 & 0 & 0 & - & 0 \\ 1 & 0 & 0 & 1 & - \end{bmatrix}.$$

The rank of RSC entities is determined to respect the concordance dominance matrix and presented in Table 4.

Table 4. The rank of RSC entities upon key stakeholders requirements' fulfillment

RSC entities	M_p	Rank
p=1	1	2-3
p=2	3	5
p=3	1	2-3
p=4	0	1
p=5	2	4

6.1. Modeling of relative importance and values

The obtained rank of RSC entities is calculated by respecting the key stakeholders' requirements fulfillment. The first place in the rank is addressed to the greatest customer of RC (p=4). This company is closely attached to the ministry for environmental protection. Due to its rigor practice, this organization has achieved a high level of business performances, so the obtained result is in compliance with the real business practice. The second and the third place is addressed to the RC (p=3) and its greatest supplier (p=1). The treated RC is the largest organization of this type of the region. It has developed a network of suppliers and customers. According to the obtained results, the weakest entities of the RSC are the second greatest supplier and the second greatest customer. Since this research is performed for the purpose of implementation of the new project in treated RSC, further analysis indicates that these two entities are in the process of implementing new business procedures and organizational changes related to the installation of new equipment. The expected effects of implementation of the project electronic waste recycling should result in satisfying stakeholders' requirements on a higher level.

7. Conclusion and future work

RSC management practice shows that the implementation of new projects is very significant from the perspective of sustainable development. It is believed that project realization related to WEEE recycling is very dependent on stakeholder activities and their requirements. While managing relationship with the key stakeholders, entities of RSC directly or indirectly tackle business difficulties and improve their business position and image. The requirements of the key stakeholders usually are not of the same importance since fulfilling the requirements imposed by the government, and legal bodies are much more significant. In that manner, the weight of stakeholders' requirements is assessed by using fuzzy Delphi method.

Each stakeholder's requirement is associated with a pair relative importance and value. Modeling of uncertainties in the relative importance of stakeholders' requirements and their value is based on fuzzy sets theory. Understanding the fuzzy approach for modeling of imprecise data is easy and straightforward. Using TFNs for modeling uncertainties offer the greatest compromise between the precision representation of uncertain information and simplicity of calculation.

The results of good practice have shown that relative importance of stakeholder's requirement does not change over time even within an uncertain environment. It is realistic to assume that determination of relative importance of stakeholder's requirement should be stated as a fuzzy group decision-making problem.

The main contributions of this paper are (1) implementation of stakeholders' analysis in RSC for the purpose of new project related to implementation of EEE recycling, (2) the assessment of relative importance of key stakeholders' requirements by using fuzzy Delphi method, (3) the ranking of RSC entities with respect to all requirements and their weighs by using ELECTRE, (4) the elements of decision matrix represent weighted normalized stakeholders' requirements values (5) an application of the conventional ELECTRE with a goal to obtain the rank of RSC entities. Priority of suitable management actions while respecting the rank of RSC entities is determined. In this way, it is possible to rationalize expenditure of various resources which can be spent for improvement of RSC entities. This can be considered as a significant contribution of the proposed model which was tested on the real-life data.

The main advantages of the proposed model can be denoted as: the complex mathematical operations do not include the changes in the number and type of stakeholders' requirements, the change of their weights and values can be easily included in the proposed model. The proposed model can be easily modified to the analysis of different management decision problems. The general limitations of the model are the subjective determination of the stakeholders' requirements.

The further research should be carried out in a larger number of RSC entities, so the set of stakeholders' requirements and their relative importance can be better defined. It is worth to mention that model is flexible in terms of entities' number of RSC or regular supply chain. As a part of the regular supply chain, this model may be used for ranking entities respecting the fulfillment criteria of their stakeholders. This can be interesting when some production systems have plans to implement some new projects.

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Snezana Nestic
University of Kragujevac,
Faculty of Engineering
Kragujevac,
Serbia
s.nestic@kg.ac.rs

Nikolina Ljepava
American University in the Emirates, College of Business Administration,
Dubai,
United Arab Emirates
nikolina.ljepava@aue.ae

Aleksandar Aleksic
University of Kragujevac,
Faculty of Engineering
Kragujevac,
Serbia
aaleksic@kg.ac.rs