IDENTIFICATION OF THE INTERDEPENDENT INFLUENCES OF MOTIVATORS FOR ENVIRONMENTAL PROTECTION IN REVERSE LOGISTICS IN THE CONDITIONS OF A DEVELOPING ECONOMY

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Abstract: *This research paper aims to investigate the interdependent influences of the motivators for environmental protection in reverse logistics in a wide spectrum of processing activities in the conditions of a developing economy. An effort was made to approach these motivators based on the relevant literature, predominant attitudes and experts' opinions, thus contributing to the body of knowledge in this domain. Determining the intensity of interdependent influences and the importance of motivators for environmental protection in reverse logistics was done to determine the most important (key) motivators, which can be practically applied as guidelines for decision-making. The DEMATEL method was used to assess the intensity of these influences on a representative sample of manufacturing companies in the Republic of Serbia.*

Keywords: Reverse Logistics, Environmental Protection, Manufacturing Industry, DEMATEL

1. INTRODUCTION

This research paper aims to investigate the presence and intensity of interdependent influences of motivators for Environmental Protection (EP) in Reverse Logistics (RL) in the conditions of a developing economy, such as the economy of Serbia. The need for this research arises from the fact that despite there is growing number of scientific publications dealing with RL and especially the application of multicriteria decision-making methods in this field, the domain is still not explored well enough so research efforts need to be intensified and expanded.

Previous studies have often been limited by the fact that they primarily focus on distinct industries (such as the electronics or automotive industry) and consider only cases of developed economies (such as USA, UK, China, India, Australia, and Brazil) (Bouzon et al. 2016; Lau and Wang, 2009; Abdulrahman et al. 2014), which makes the results difficult to generalize. This has led some researchers to express their concern about the absence of similar studies focusing on developing countries, as they might not be able to fully utilize findings from the aforementioned studies (Sarkis et al. 2011; Zhang et al. 2011).

Coupled with the rising awareness of the importance of RL and its slowly gaining a foothold in developing countries as well, in order to maximize chances of implementing it successfully critical motivators for EP have to be identified first so that they can be appropriately addressed. This paper makes a contribution in this regard, as it is one of the nascent empirical efforts of this kind to be carried out on the territory of the Republic of Serbia. This research was part of a broader research, with a larger number of examined elements in the field of motivators and barriers for the implementation of RL in organizations and their impact on organizational performance, and represents one of its segments (Brkljač, 2017).

The study, will present first a systematization of key motivators for EP in RL based on relevant literature sources, as well as on the prevailing views and opinions in this scientific field. After that, they will be defined the primary and secondary goals of the research, which is to identify their interdependent influences and to determine the significance of these motivators respectively. Finally, will be highlighted and briefly discuss those that are of key importance according to our results. Besides having academic value, we also believe that our findings will be useful to professionals in this domain since they can serve as guidelines in the decision-making process when implementing RL in organizations operating in similar conditions.

2. MOTIVATORS FOR ENVIRONMENTAL PROTECTION IN REVERSE LOGISTICS

By reviewing the literature, in order to determine and classify the most frequently cited motivators for the implementation of RL in organizations, it was found that they are most often grouped according to the criterion of their essential impact - economic, social and impact on EP, but for the purposes of this research, the focus is on EP. Shaik and Abdul-Kader (2014) point out that due to trends and incentives for the development of social responsibility of organizations, as well as legislation in the field of the environment, organizations must constantly take into account their context of expectations of interested parties, in order to achieve balanced development from the aspect of EP, social and economic aspect.

Corporate social responsibility refers to a set of values or principles that make the organization socially responsible towards the community in which it operates. It refers to the organization's responsibility for the impacts of its decisions and activities on society and the environment, through transparent and ethical behaviour (ISS, 2011). For this reason, RL activities can lead to gaining competitive advantages in the market (Carter and Ellram, 1998), improving the corporate image (Chan et al., 2012) and generally creating the image of a "green organization" (Mangla et al., 2016; Chileshe et al., 2016; Akdoğan and Coşkun, 2012; Ravi and Shankar, 2005; Walker et al., 2008; Kapetanopoulou and Tagaras, 2011; Chinda, 2017).

Various pressures from supplier chain partners, such as reducing supply chain waste, reducing pollution and sources of waste, suppliers rating based on sustainable practices and products, with reduced environmental, and social impacts, reduced harmful waste or materials, holistic approach for sustainable performance improvement and proactive sustainable supply chain management, are improving competitive advantage and drive the organization for the sustainable manufacturing (Hariyani et al., 2023).

The extended responsibility of producers, i.e. the right or obligation to return their products, after the expiration date or the end of the product's life, generate and intensify the collection and reuse of products (Akdoğan and Coşkun, 2012), the use of recycled materials (Ravi and Shankar, 2005), lowering the costs of waste management, reducing the amount of generated waste and reducing the necessary capacity for waste disposal (Govindan and Bouzon, 2018; Ravi and Shankar, 2015). Questions related to waste management also include suggestions that used products do not necessarily need to be disposed of in landfills, but can be reused or recycled by applying the "cradle to cradle" concept, through repair, reuse, "refurbishing", reproduction or recycling of usable and valuable products or materials (Chan et al., 2012), highlighting the importance of establishing a circular economy. In the context of the circular economy, RL management assists in closing supply chain loops and building partnerships to promote practices such as recycling and remanufacturing (Barros et al., 2021).

The availability of raw materials due to the use of already used ones, with renewed use value and the reduction of the need for new, often non-renewable resources, become one of the primary goals of organizations that strive to respect the principles of sustainability in their business and decision-making (Akdoğan and Coşkun, 2012; Rahman and Subramanian, 2012; F. T. S. Chan and Chan, 2008; Ravi and Shankar, 2005; Chinda, 2017; Mangla et al., 2016; Lau and Wang, 2009). The need to rationalize the use of resources in production processes and supply chains represents a trend in the modern way of doing business while numerous scientific papers support the importance of effective supply chain management (González-Sánchez et al., 2020). The need for competitiveness and elimination of negative effects of business activities and decisions requires organizations to explore ways of reusing the materials or products' components and restore the value of the material and energy inputs for a longer period of time (Rajput et al., 2019).

For the purposes of this research, a systematization and grouping of EP motivators (factors) was carried out. These factors were defined based on a review of the literature and their semantic analysis, where adjustments were made in order to eliminate redundancy in the statement and adequate understanding by the respondents. Accordingly, motivators for EP can be divided into:

- reducing the level of environmental pollution, due to the reduction of the amount of waste (C13),
- reducing the space required for waste disposal (C14),
- preserving natural resources and reducing the use of new raw materials (C15) and
- creating the image of a "green organization" (C16).

3. RESEARCH METHODOLOGY

In order to efficiently manage the process of RL implementation in an organization, it is necessary to comprehensively study the factors that may affect that process. There are several different motivators for EP in RL and they have an interdependent influence. In this case, management has to define priorities in providing resources and intensifying their positive impact on the implementation of RL in organizations. This is a classic example of Multiple Criteria Decision Making (MCDM), so it is necessary to determine the intensity of mutual influences of motivators in order to provide a solid foundation for effective decision-making. The DEMATEL method (Decision Making Trial and Evaluation Laboratory) is often used for this purpose as it represents a comprehensive method for analysing and solving complex and interdependent problems. It is intensively applied in the field of RL and supply chains, especially when determining the interdependent influences of RL implementation factors (Wang et al., 2016; Bouzon et al., 2018; Jalalifar and Kiamars, 2013; Xia et al., 2015; Shaik and Abdul-Kader, 2014; Gandhi et al., 2015; Mangla et al., 2016; Rahman and Subramanian, 2012; Wu et al. 2015a).

The DEMATEL method is based on graph theory and enables visual planning and problem-solving in such a way that relevant factors can be divided into causal and consequential so as to better understand their interrelationships. The resulting graph shows the contextual relationship between the elements of a system in which the number represents the strength of the influence of a factor. The procedure for calculating the intensity of the mutual influences of these factors comprises five steps (Wang et al., 2016; Bouzon et al., 2018; Xia et al., 2015; Gandhi et al., 2015; Mangla et al., 2016; Rahman and Subramanian, 2012; Wu et al. 2015a; Li and Tzeng, 2009).

Step 1: Generating matrices of scores (attitudes) of experts - $x_1, x_2 .... x_e$. Suppose it is assumed that there are e experts in a study and n factors to be considered. In that case, each expert indicates (evaluates) the degree of influence that factor *i* exercises on factor *j*. The value of each pair x_{ijk} is an integer, where the following integer scale is used: 0 - no influence; 1 - very low influence; 2 - low influence; 3 - high influence; 4 - very high influence.

Step 2: Calculating the matrix of average values of experts' scores (Average Matrix) - A.

Step 3: Calculating the normalized influence matrix (Initial Direct-Relation Matrix) - D.

Step 4: Computing the matrix of total influences - T.

The value ri represents the sum of the i-th row of the matrix T and shows the total effect, both direct and indirect, which factor *i* has on other factors. The notation c_j represents the sum of the *j*-th column of the matrix T and shows the total direct and indirect effects, which factor *j* received from the other factors. The expression (r_i+c_j) represents the importance of the factor, i.e., the degree of influence a particular factor has on the observed problem. The expression (r_i-c_j) denotes the intensity of the influence of the effects of a factor, in relation to other factors. If the expression (r_i-c_j) is positive, factor *i* exerts influence on other factors, i.e., the change conditioned by the action on factor i causes the change of other factors. If the observed expression is negative, factor i receives influence which comes from the effects of other factors.

Step 5: Determining the limit value of the importance of factor influence (Threshold Value) - p and constructing diagrams of mutual influences of the observed factors. Based on the opinion of the respondents (experts) or researchers, the lowest value of the importance of the influence of the factor - *p* is determined. This value is used to filter low values of the intensity of the influence among the factors of the matrix T, i.e., the values that are lower than the defined threshold value. Filtering is performed on all elements of the matrix T so that the values that are lower than the determined value of *p* get a value of 0 while the other elements of the matrix T, which are higher than the value of *p*, retain the existing value. If the defined value of *p* is too low, the presentation of the system structure will be inadequate, complex and difficult to understand for the decision-makers. The value of *p* which is set too high makes the structure of the system simplified, but it can lead to neglect and oversight of important influences in the system. Based on the determined value of *p* and filtered values in the matrix T, a diagram of mutual influences of the observed factors is constructed, which enables an easier understanding of factor relations in the observed system and facilitates the decision-making process based on results obtained by applying this method.

The research instrument used in this study was a questionnaire, which was devised based on the key elements in terms of motivators for EP in RL, as described in Section 2. There were two groups of respondents, who were selected from the ranks of experts in the field of logistics. The first group comprised respondents from the academic community (three university professors who specialize in the field of logistics) who also served as validators for the devised questionnaire. After a consensus among

them was reached on the suitability of the questionnaire, it was sent to the second group of respondents. This group consisted of 23 respondents who were recruited for the study from companies in the Republic of Serbia which belonged to the processing sector. All the respondents who participated in the research worked and / or managed logistics in their organizations for a considerably long time and were familiar with the concept of RL and its importance in the functioning of the logistics function and supply chains of these organizations. After being provided with the guidelines, the respondents completed the questionnaire.

Overall, 26 questionnaires of this type were collected and the received answers were converted to a set of matrices, which were subsequently used as input to the DEMATEL method. Based on the description of samples and the recommendations from the literature (Bouzon et al., 2018; Gandhi et al., 2015; Wu et al. 2015a; Wu et al., 2010; He and Cheng, 2012; Wu et al. 2015b), it can be said that the sample used is representative of the research population, i.e., the processing sector of the Republic of Serbia.

4. RESULTS

On the basis of the completed questionnaires, matrices with scores (evaluations) of the experts who participated in the research were formed. After the matrices of evaluation scores were formed, the matrix of average values of the experts' scores - matrix A was calculated, which represents the mean value of the scores of all the experts included in the study and is presented in Table 1, as an excerpt (with sums of the columns and sums of the rows).

The next step involved calculating the normalized influence matrix - *D*, using the formula *D=A/s*. The value of *s* represents the maximum value of the sum of all rows and columns, and is 10,077, as shown in Table 1. After calculating the normalized impact matrix (Table 2), the total impact matrix – *T* was calculated. Table 3 shows the matrix of total influences for the observed motivators (with sums of the columns and sums of the rows). It can be observed, as shown in Table 4, that the motivators C15 and C16, are factors whose effects influence (EI) other factors. The motivators C13 are factors that are influenced (receives influence - RI) by the effects of other factors. From the aspect of the significance of RL implementation for in organizations, the most significant motivators for EP in RL are C13, C16 and C15.

For the purpose of constructing a diagram of interdependent influences of the observed factors, the threshold value of the importance of the influence of factors (Threshold Value) - *p* is defined. According to some authors, this value can be defined on the basis of expert opinion or on the basis of calculations. In the present study, it is defined according to the recommendations in the literature (Gandhi et al., 2015; Mangla et al., 2016; Rahman and Subramanian, 2012; Wu et al. 2015a; Wu et al., 2010; Hsu et al. 2007) as the average value of the T matrix and is 5,485. Based on that, a filtered matrix of total interdependent influences was formed (Table 5). Figure 1 shows a diagram of the interdependent influences of motivators for EP in RL, formed on the basis of the values from Table 4 (the position of points in the diagram coordinate system) and on the basis of the values from the filtered matrix of total interdependent influences (connection of points based on *p* values of the importance of factor influence). The diagram enables a graphical display of data to facilitate the observation and understanding of the relationship of factors in the observed system. Each link line indicates the influence between the two variables, and the arrowhead indicates which variable is influenced by the other in the relationship shown. In the case of a connection, the arrowheads located on both sides indicate the mutual influence of the observed variables.

Table 1: The matrix of average values of the experts' scores - A

	C13	C14	C15	C16	∑
C13	0	3,231	3,231	3,231	**9,692**
C14	2,846	0	2,923	2,462	**8,231**
C15	3,154	2,846	0	3,615	**9,615**
C16	3,846	2,846	3,385	0	**10,077**
∑	**9,846**	**8,923**	**9,538**	**9,308**	

Table 2: Normalized impact matrix

	C13	C14	C15	C16
C13	0	0,328	0,328	0,328
C14	0,289	0	0,297	0,250
C15	0,320	0,289	0	0,367
C16	0,391	0,289	0,344	0

Table 3: Total impact matrix – T

	C13	C14	C15	C16	∑
C13	5,611	5,453	5,725	5,634	**22,423**
C14	5,168	4,588	5,056	4,949	**19,761**
C15	5,846	5,421	5,470	5,649	**22,386**
C16	6,086	5,609	5,922	5,573	**23,190**
∑	**22,711**	**21,071**	**22,172**	**21,806**	

Table 4: Importance and intensity of influence – motivators

importance	1	4	3	2
(r_i+c_j)	45,133	40,831	44,558	44,996
factor	C13	C14	C15	C16
(r_i-c_j)	-0,288	-1,310	0,214	1,384
contribution	***reciever***	***reciever***	***cause***	***cause***

Table 5: Filtered matrix of total interdependent influences

	C13	C14	C15	C16
C13	5,611	0,000	5,725	5,634
C14	0,000	0,000	0,000	0,000
C15	5,846	0,000	0,000	5,649
C16	6,086	5,609	5,922	5,573

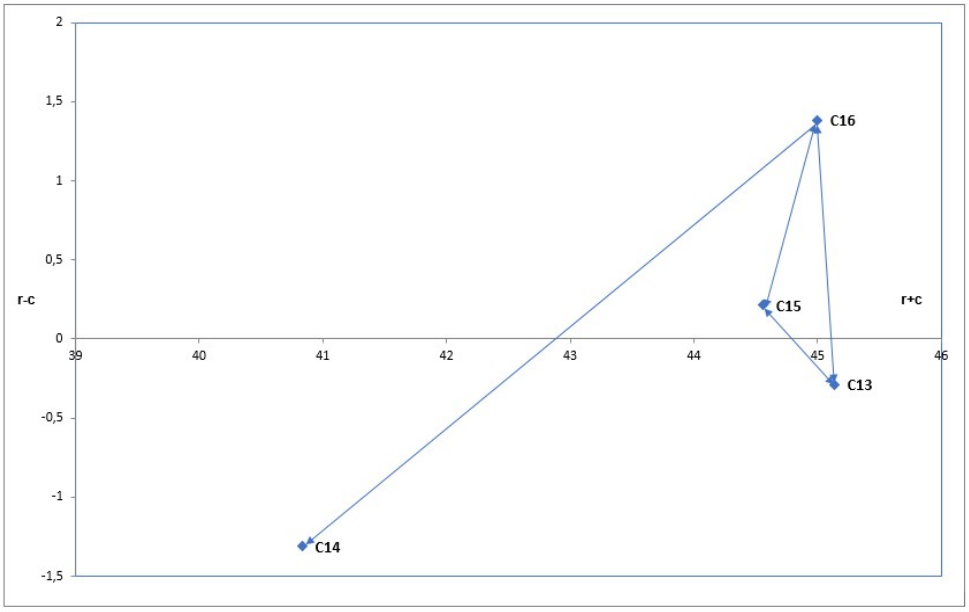

Figure 1: Diagram of the interdependent influences of motivators for environmental protection in reverse logistics

After analyzing the interdependent influence of motivators for EP in RL it can be concluded that, according to the level of importance for RL implementation, the most important motivators for EP are a reduction in the level of environmental pollution, due to a reduction in the amount of waste (C13), creating the image of a "green organization" (C16), as well as preserving natural resources and reducing the use of new raw materials (C15), while reducing the space required for waste disposal (C14) has the lowest level of significance of the observed factors. Viewed from the aspect of influence on other factors, motivators C16 and C15 influence the other mentioned motivators with their presence and encourage their persistence. For this reason, it can be said that C16, C15 and C13 are the key motivators for making a decision on the implementation of RL, from the aspect of sustainability in terms of EP, which is in agreement with the views of literary sources and the views of the authors, stated in chapter 2. It is obvious that the respondents believe that the motivation for the implementation of RL, from the aspect of EP, relies on creating the image of a "green organization", through a higher degree of utilization of materials from reverse flows and a reduction in the amount of generated and disposed waste.

5. CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

The primary goal of this research was to identify the interdependent influences of motivators for EP in RL. In order to achieve this goal, the views of the academic community were reviewed and, based on relevant literature sources, motivators were identified and grouped. The secondary goal was to determine the significance of these motivators and highlight those that are of key importance so that they can be prioritized and appropriately addressed. At the same time, this study contributes to the growing body of knowledge in the domain and is particularly relevant for practitioners and academics coming from or operating in developing economies – as it indicates that expectations, conclusions and phenomena observed in the conditions of developed and stable economies may not necessarily translate well to developing countries. In practical terms, the results obtained from the present research can be especially useful for organizations operating in similar market conditions to those of the Republic of Serbia, as they can serve as guidelines for their management to direct resources more efficiently in the decision-making process.

The comparison of the results of this research with the theoretical considerations also suggests that there is an awareness of the importance of applying RL in the processing sector of the Republic of Serbia, in order to achieve the competitive advantages of organizations, but also to preserve the environment and natural resources. The lack of awareness about this has often been identified and especially expressed as a barrier to the application of RL in developing countries. Also, it appears to be necessary to define mechanisms and regulatory frameworks to encourage organizations to implement this concept, primarily through the cooperation of organizations and experts in the field of logistics with scientific and government institutions. The goal of this cooperation should be the exchange of information and joint action in the development of legislation that regulates this area and provides the conditions for its sustainability.

Based on the results of this study, we have identified several promising avenues for future research which may contribute to the implementation of RL in organizations, such as:

- Determining employees' competencies and experiences that are necessary to overcome barriers and formally expressing the way in which they contribute to the efficient and effective implementation and functioning of RL;
- Understanding the effects of deeper involvement of government departments on devising a more holistic view of the strategies for sustainability;
- Investigation of the connection between individual RL activities and criteria for selecting adequate implementation options and influences of individual RL activities on improving organizational performance;
- Comparison and better understanding of experts' attitudes and opinions between developing and developed economies, when it comes to overcoming RL implementation barriers.

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