Green Logistics in Slovak Small and Medium Wood-Processing Enterprises

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Current approaches in logistics are focused on sustainable development of enterprises and society. Small and medium enterprises (SMEs), in this case wood-processing enterprises, can achieve this goal by implementing green logistics strategies in business practice. The main objective of this paper is to propose an algorithm for the implementation of green logistics activities in wood-processing SMEs, through a survey aimed at analyzing the accelerators and barriers to implementation in business practice. The research has been evaluated *via* methods of testing the statistical hypothesis (binomial test, Chi-squared, Friedman test, Wilcoxon test), methods of descriptive statistics, and data visualization. The survey found that one of the most significant determinants for implementing green logistics activities in a wood-processing enterprise is a decrease in cost. Based on the performed analysis, a model for the implementation of green logistics activities for wood-processing SMEs was proposed that includes appropriate activities that ensure the sustainable development of wood-processing SMEs in Slovakia.

Keywords: Green logistics; Wood-processing small and medium enterprises (SMEs); Sustainable development; Model

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INTRODUCTION

Interest in environmental issues and sustainability is rising worldwide, pushing enterprises to take more and more responsibility for their products and services (Alkhidir and Zailani 2009; Musa *et al.* 2015; Ivascu and Cioca 2015; Hajdúchová *et al.* 2016). In this context, the logistics of enterprises should represent the effort to synchronize, coordinate, and optimize the information and material flows, to satisfy the needs of customers, at adequate costs, and with minimum negative effect on the environment. Linking the logistics processes with ecological goals forms the nature of green logistics (GL) (Dekker *et al.* 2012).

Literature Review

Based on several research papers (Orsato 2006; Holt and Ghobadian 2009; Mollenkopf *et al.* 2010; Duan 2015), the concept of GL can be understood as a logistical direction aiming to minimize the impact of business activities on the environment. It can therefore be suggested to think of green logistics as a process of environmental planning, application, and managing the effective and efficient environmental flow and storage of goods, services, and related information, from the point of origin to the point of

consumption. This is followed by recycling, ecological liquidation, and reuse of the products, the main objective of which is to behave in an environmentally friendly manner toward all stakeholders, thus achieving their satisfaction. At the same time, it is important to create an economically, ecologically, and aesthetically appropriate premises with a healthy internal environment, which helps to conserve energy and other resources in the enterprise.

According to statistics, almost 60% of customers ask if the goods or services fulfill the ecological criteria (Dekker *et al.* 2012). This information is not only found online, but there are also mobile applications that inform customers about ecologically responsible brands. A green enterprise should offer green products. During production, green enterprises decrease water consumption, reduce waste, and apply recycling programs. They also use responsible packaging, made of recycled materials, for their products, or recyclable packaging. Similar principles apply to ecological design.

In addition to the fact that a green enterprise attempts to minimize pollution of the environment, it also reduces the ecological impact of its production beyond legal responsibilities. A green workplace means everyday savings on energies, careful material handling, and recycling at the workplace.

Based on multiple research papers (Zhu and Sarkis 2004; Modi and Mabert 2006; Shibi and Englese 2009; Jabbour *et al.* 2015; Mafini and Muposhi 2017), the main assets that the implementation of GL offers to an enterprise are as follows: reduction of the total operational costs; reduction of waste; reduction of fuel and energy consumption; optimization of the logistics flows; and reduction of emissions and use of toxic materials. As Faletar *et al.* (2016) stated, an enterprise can further benefit from developing new, recyclable products; increasing customer, employee, and other stakeholders' satisfaction; improving the position and the name of the enterprise in the market; *etc*. Implementation of green logistics activities means the enterprise is making an effort to minimize the negative impacts on the environment. On the other hand, there are factors that could represent a potential disadvantage for the enterprise when deciding to take this path. The implementation of GL should be proposed in a way that enables the enterprise to reduce costs. However, the initial costs are financially demanding, as environmentally friendly technologies (energy saving) are very costly to procure. Similar to purchasing eco products, *etc*., there is another potential disadvantage of being green – time. The implementation of GL activities may be a time-consuming project. For instance, searching for environmentally acceptable suppliers can take a long time because they may be located further from the 'green' enterprise, which could result in higher input costs (Min and Galle 2001). The time factor can also represent a problem for return on investments. To be green may in fact have a potentially negative effect on the environment as well. One of the latest trends is the use of ecological vehicles, which helps the enterprise to cut the amount of emissions in the atmosphere (Alkhidir and Zailani 2009).

Micro, small, or medium enterprises play an important role in the European economy, as well as the Slovak economy. According to data from the Slovak Business Agency for the year 2016, small and medium enterprises (SMEs) in the Slovak Republic represent as much as 99.9% of the total number of entrepreneurial subjects, provide job opportunities for nearly 75% of the active workforce, and contribute to gross production and creation of added value by more than 50%. Additionally, they are a source for new innovations and technologies, create a competitive environment, enhance economic growth, and at the same time produce and offer products or services that large corporations are not willing to provide (Sedliačiková *et al.* 2016; Vinczeová *et al.* 2016).

The wood-processing industry in the Slovak Republic is relatively independent of importing natural resource inputs, being built on a domestic resource base of sustainable character, and therefore it is able to permanently show an active balance of foreign trade. In relation to the positive situation related to natural resources, their suitable geographic location, and their acceptable energetic demands for processing wood, the wood-processing industry represents an important field of industry for the Slovak national economy, while thus enabling further development of small and medium enterprises (Hajdúchová *et al*. 2016). The wood-processing industry comprises the wood, furniture, and cellulose-paper industries. These are based on processing wood, a domestic ecological resource.

According to the Union of Wood Processors, among the main characteristics of the wood and furniture industries in Slovakia are the following (SAWP 2016):

- independence of importing material inputs – sufficient material base,
- high proportion of small and medium enterprises (95%),
- low purchasing power of citizens of Slovakia – orientation on cheap furniture products from Central European countries (which are of lower quality, but less costly),
- crucial source of work opportunities in several regions of the Slovak Republic,
- decline in traditional furniture production,
- low economic power of Slovak enterprises with lack of foreign capital, and high indebtedness.

It may be assumed that there is a considerable potential for modernization and development of wood-processing industry in the field of green logistics, where opportunities are seen in reducing the negative environmental impacts not only in wood-processing, but also in producing wood products.

The goal of this paper is to introduce green logistics activities in Slovak wood-processing SMEs and to determine the accelerators and barriers to their implementation in practice. The result of our research is the proposal of a framework model of green logistics implementation in the practice of Slovak wood-processing SMEs, including appropriate activities while ensuring sustainable development.

EXPERIMENTAL

The research methodology consisted of three phases. In the first phase, methods of summary, synthesis, and analysis were used, and a short review was prepared. In the second phase, a questionnaire was administered to generate empirical data on Slovak wood-processing SMEs. To evaluate the results of the research, the statistical program IBM SPSS Statistics 19 (Armonk, New York) was used. The results in the output tables are rounded off to three decimal places. In the third phase, a model of implementation of green logistics activities for wood-processing SMEs was proposed, which includes appropriate activities that ensure the sustainable development of wood-processing SMEs in Slovakia.

Data Collection

The subject of this research was wood-processing SMEs in Slovakia. The object of the research was green logistics.

The primary data were collected through a questionnaire, which consisted of two parts.

Part A - 2 questions: Type of enterprise (A1 – A2),
Part B - 6 questions: Green logistics (B1 – B6).

Part A consists of two questions focusing on identification of the participating enterprises. Question A1 asks about the size of the enterprise based on the number of employees (micro enterprises have 1 to 9 employees, small enterprises have 10 to 49 employees, and medium enterprises have 50 to 249 employees). Question A2 focuses on the market the enterprise operates in: local, regional, national, European, or global.

Part B consists of six questions focused on finding out how wood-processing SMEs in Slovakia perceive the implementation of green logistics activities. Question B1 asked what respondents understood by the term green logistics. This question was evaluated on the Likert scale, where 1 is the weakest and 5 is the strongest agreement. The Likert scale enables us to find out, not only the content of the opinion, but also its strength. In question B2, respondents were asked to choose only one of the given options. The question focused on finding out if the green logistics activities apply to their individual business practice. Questions B3 and B4 asked which green logistics activities, and activities of reverse logistics, the enterprise was implementing or planning to implement. Respondents had the following options: 1 – not planning at all, 2 – planning in long-term, 3 – planning in short-term, and 4 – already implementing. Questions B5 and B6 found out what would most likely persuade the respondents to apply GL, and, on the other hand, where they see the biggest barriers to its application. Respondents could choose three options with the greatest impact.

Sample Size

The sample was composed of Slovak wood-processing SMEs. In 2016, the Slovak Association of Wood Processors identified approximately 7,845 wood-processing companies (SAWP, 2016). The questionnaire was sent *via* e-mail to 2,500 randomly selected wood-processing SMEs. The research data were collected from 567 wood-processing SMEs in Slovakia. The sample size was determined using the following equation (Scheer 2007),

$$n = \frac{z_{\alpha/2}^2 \cdot p(1-p)}{\Delta_p^2} \quad (1)$$

where n is the size of the sample set, $z_{\alpha/2}^2$ are the values of the standard normal random variable (reliability specified at the 95% level, *i.e.*, $\alpha = 0.05$ corresponds to $z = 1.96$), Δp is the required exactness (error of estimation determined at 5.65%), and p is the ratio (relative frequency) quality sign in the basic set (determined at 50%). On the basis of this calculation, it was concluded that the size of the sample was sufficient.

A total of 958 filled questionnaires were returned, which represents 37.8% of the total distributed. For the purposes of the research, 567 correctly filled questionnaires were

used. This was considered to be a representative sample size. The actual sample size decreased the error of estimation to 3.99%.

Methods of Evaluation of the Research

The survey data were evaluated based on descriptive, graphical, and statistical analyses. When testing the hypothesis, we worked with a significance level of 0.05. On the basis of the theoretical foundations and empirical studies dealing with the given problem, the following hypotheses were formulated.

It is assumed that:

H_0: more than one quarter of wood-processing SMEs in Slovakia demand application of green logistics activities;

H_1: most wood-processing SMEs in Slovakia have already applied at least five green logistics activities;

H_2: in the business practice of wood-processing SMEs in Slovakia, the most significant advantage of implementation of green logistics activities is reducing costs;

H_3: in the business practice of wood-processing SMEs in Slovakia the enterprises consider the investment costs as the biggest barriers of implementing the green logistics activities.

When evaluating the research results, the following methods of testing statistical hypotheses were used: binomial test, Chi-squared, Friedman test, Wilcoxon test), methods of descriptive statistics and data visualization (mean, modus, median, skewness, and frequency tables).

When formulating the hypothesis H_0, the results of the research conducted by Grafland and Smid (2016) were used as the basis. The given research built upon the results of the research conducted by the European Union, which found out that 25% of SMEs have formulated their environmental goals. Thus is can be assumed that 25% of wood-processing SMEs require implementation of GL activities from their employees. On the basis of hypothesis H1, question B3 was formulated. Specification of GL activities is a result of comparing the results from the following research: Diabat and Govindan (2011), Seroka-Stolka (2014) and Cosimato and Troisi (2015). Considering the fact that SMEs in Slovakia have limited financial resources, it can be stated that GL activities may not only increase the efficiency and performance of the enterprise, but also, at the same time, improve its image. This leads to a conclusion that it is possible to assume specification of at least five GL activities, while it is not essential which activities from question B3 they are. The stated frequency has been suggested by an expert estimation based on a complex study of the given problem. Hypotheses H_0 and H_1 were tested by the exact binomial test, which tests the null hypothesis in agreement with the population proportion. Sample proportion was calculated from the frequency table, which shows the distribution of the responses to question B3 of the research.

Various authors claim that SMEs have a lack of financial resources that would be assigned for their development. On the basis of this statement, hypotheses H2 and H3 were formulated, which verify the most significant advantage, as well as the barrier, to implementation of GL activities. To evaluate the questions and test hypotheses H_2 and H_3, the Friedman and Wilcoxon tests were used. The Friedman test is the analog of the analysis of variance for a design with two factors and can be applied to data sets that do not meet the assumption of the parametric approach, namely normality and homogeneity of variance (Everitt and Skrondal 2010). It verifies the agreement of the medians for k ($k > 2$) signs with the same categories, *i.e.*, for k-related samples with the same sample size *n*. The

Wilcoxon signed rank test is used to test the difference between two populations using matched samples. The test is based on the absolute difference of the pairs of observations in the two samples, ranked according to size, with each rank being given the sign of the original difference. The test statistic is the sum of positive ranks.

Pareto analysis (Lambert *et al.* 2010) was used to identify the key activities of green logistics, as well as the key barriers to its implementation.

RESULTS AND DISCUSSION

Results of Empirical Research

A total of 567 enterprises participated in the research related to green logistics in wood-processing SMEs in Slovakia. Their structure according to size (number of employees), and the market the enterprise operates in are presented in Table 1.

Table 1. Structure of the Addressed Enterprises by Size and the Market of the Enterprise

	Number of employees					
	0-9	**10-49**	**50-249**			**Total**
Frequency	482	67	18			567
%	85.0	11.8	3.2			100
	Market of Enterprise					
	local	**regional**	**national**	**European**	**global**	**Total**
Frequency	190	176	106	69	26	567
%	33.5	31	18.7	12.2	4.6	100

The term logistics can have many meanings, depending on the stage of development. The current trend in logistics is to be environment-friendly. In question B1, the respondents could express their level of agreement with the given statements, which describe the content of green logistics. This question was evaluated by modus; at the same time, skewness (asymmetry) was determined for the individual options.

The surveyed wood-processing SMEs in Slovakia expressed high agreement (values 4 and 5) with the above statements. The strongest agreement (5) at the highest skewness (-1.001) was expressed with the statement "green logistics is using environmentally friendly packaging". Using ecologically acceptable packaging truly reduces the negative impact on the environment because it greatly simplifies the process of recycling (Fernandéz 2004). In addition, using certain ecological packaging also reduces the amount of waste created with unsold goods, as it prolongs its durability. If an enterprise wants to improve this area of logistics, it is essential for it to deal with waste economy and recycling. The results of our research show that the weakest agreement of the enterprises (level of agreement is 3, skewness -0.310) is with the statement that green logistics is the ecologically appropriate processing of waste. A strong agreement (5) at skewness -0.992 was expressed with the statement that it is an ecological way of transporting materials and goods. Transportation is one of the essential components of logistics and has a great impact on the environment. There are, however, other logistics activities that represent great potential in an enterprise's efforts to behave ecologically, and this should not be forgotten.

Question B2 asked about the status of green logistics in wood-processing SMEs in Slovakia, and to what extent the enterprises require and demand their fulfillment. It was determined that 37.9% of respondents have already encountered some activities of green logistics in their enterprise. However, GL is not standardized in their corporate documentation. The absence of corporate documentation as a form of communication in an enterprise makes it necessary to constantly start over and prevents the continuity of management. A positive finding is that 24.9% of the addressed SMEs define the activities of green logistics in their corporate documentation and require full or partial engagement of employees. It was found that 3.9% of the enterprises that participated in the present research define green logistics activities in their corporate documentation but do not require their application. As many as 33.3% of the respondents stated that they have never encountered green logistics activities in their enterprise.

To compare, a reference can be made back to research (Duan 2015) related to implementation and performance of green logistics, which was conducted in 107 enterprises in China and Japan. The findings of the research show that implementing green logistics in enterprises is more popular in these countries when compared with Slovakia. Implementation was confirmed in 65% of the addressed enterprises (Scupola 2003).

The question discussed above relates to two of our hypotheses: H_0 and H_4. When evaluating the hypotheses, wood-processing SMEs in Slovakia were divided into two groups. The first group was represented by the enterprises that have provided the answer that "the enterprise fully or partially requires implementation of green logistics activities" in question B2. Enterprises that do not require implementation of green logistics activities formed the second group of respondents. The validity of hypothesis H_0, which assumed that more than a fourth of wood-processing SMEs in Slovakia require implementation of green logistics activities, was assessed using the exact binomial test. The results of the binomial test are presented in Table 2.

The results of the binomial test lead to rejection of hypothesis H_0 (p-value = 0.494). The results of the exact binomial test did not confirm the assumption that more than one fourth of wood-processing SMEs in Slovakia require the implementation of the green logistics activities. Hypothesis H_0 was rejected.

Table 2. Binomial Test for H_0

Binomial Test						
		Category	N	Observed Prop.	Test Prop.	Exact Sig. (1-tailed)
	Group 1	1.00	141	0.25	0.25	0.494a
B2_requires	Group 2	0.00	426	0.75		
	Total		567	1.00		
a. Alternative hypothesis states that the proportion of cases in the first group < 0.25						

Logistics offers a whole range of options for how to effectively contribute to sustainability. The present research focused primarily on the environmental added value, *i.e.*, the voluntary environmental activities of enterprises that exceed the obligations given by the legislature (Table 3). Enterprises are increasingly realizing the impact of their activities on the environment, and the results of our research have confirmed this. Based on the data obtained in the primary research, as well as the results of the Friedman test, it may be expected that the green logistics activities are not as important for enterprises with

respect to the timeframe of planning and implementing these activities (p-value < 0.001). The Wilcoxon sign test (Table 3) verified the significant difference related to the importance of planning these activities and implementing them.

It can be stated that in the field of green logistics, wood-processing SMEs in Slovakia are most active in separating and recycling waste. Using electronic invoicing is also important (lowering the consumption of paper), as well as increasing the effectiveness of loading the transported goods (maximum utilization of capacity, method of storing the goods, *etc.*). Such green logistics activities as using renewable sources of energy and using more efficient vehicles demonstrate lower planning activity. The lowest planning activity of wood-processing SMEs in Slovakia was observed in environmental education of customers.

Table 3. Wilcoxon Sign Test for Question B3

	B3p - B3o	B3j – B3p	B3f - B3j	B3i - B3f	B3r - B3i	B3h - B3r
Z	-6.009[a]	-4.596[a]	-3.744[a]	-0.462[b]	-0.652[a]	-3.322[a]
Asymp. Sig. (2-tailed)	0.000	0.000	0.000	0.644	0.515	0.001
	B3g - B3h	B3b - B3g	B3c - B3b	B3d - B3c	B3k- B3d	
Z	-2.095[a]	-3.365[a]	-0.097[a]	-2.283[a]	-1.399[a]	
Asymp. Sig. (2-tailed)	0.036	0.001	0.922	0.022	0.162	
	B3n - B3k	B3m - B3n	B3l- B3m	B3a - B3l	B3e - B3a	
Z	-0.644[a]	-0.906[a]	-1.505[a]	-1.054[a]	-3.443[a]	
Asymp. Sig. (2-tailed)	0.519	0.365	0.132	0.292	0.001	

a. Based on positive ranks. b. Based on negative ranks. c. Wilcoxon sign ranks test

a. certification in the field of environment;
b. using sustainable sources of energy;
c. adjusting vehicles to achieve lower consumption;
d. environmental education of employees;
e. environmental education of customers;
f. reducing the amount of packaging materials;
g. using methods of transport that are more environmentally friendly;
h. ecological ways of driving;
i. optimizing transportation routes;
j. effective loading of the transported goods;
k. reducing CO_2 emissions as part of the fundamental corporate goals;
l. gathering information on energy consumption and CO_2 emissions;
m. cooperating with partners to achieve environmental goals;
n. cooperating with customers to achieve environmental goals;
o. separating and recycling waste;
p. using electronic invoicing;
r. having an ecological office

This question was related to hypothesis H_1. Hypothesis H_1, which assumed that the majority of wood-processing SMEs in Slovakia have already implemented at least five

green logistics activities, was planned to be verified by binomial test. Based on the data from the frequency table (Table 4), it was found that only 41% of the addressed enterprises have already implemented at least five of the activities of green logistics. The results of the research did not support verification of this hypothesis. Therefore, hypothesis H_1 was not confirmed.

Table 4. Frequency Table for H_1

Statistics					
B3 at least 5					
N	Valid			567	
	Missing			0	
B3_at least5					
Valid		Frequency	Percent	Valid Percent	Cumulative Percent
	0	336	59.3	59.3	59.3
	1	231	40.7	40.7	100.0
	total	567	100.0	100.0	

Reverse logistics, which is used in the processes of repeated use of material, appears to have a great potential within green logistics. The processes enable the reduction of the use of resources by increasing the lifecycle of the products or their components (Monson 2014). Use of reverse logistics activities in wood-processing SMEs in Slovakia, with the goal to protect the environment, was examined in question B4.

Results of the Friedman test show that the significance of the individual activities of reverse logistics in wood-processing SMEs in Slovakia is not the same (p-value < 0.001). Using the Wilcoxon signed rank test, it can be concluded that there is evidence that the most important activity of green logistics in wood-processing SMEs in Slovakia is recycling waste and packaging. Similar research, conducted in 2000 on a sample of 188 enterprises in the USA, Canada, and the European Union, focusing on the strategy of green logistics, confirmed that recycling of goods is used by more than 80% of enterprises, and reusing the materials is applied in nearly 75% of enterprises (Modi and Mabert 2006). These data indicate that Slovak wood-processing enterprises, even after 15 years, have not reached the level of recycling that enterprises that participated in the cited research of 2000 had achieved at that time. Only 54.8% of wood-processing SMEs in Slovakia have already implemented this recycling, and 12.0% plan to implement recycling of products and packaging soon.

The Pareto analysis (Table 5) proved that 74.4% of enterprises that participated in the research are using returnable packages in the process of packaging their products and thus are increasing the opportunity to reuse the same packaging in accordance with the environmental policy of the European Union. Reusing packaging lowers costs for the enterprise and is beneficial for the environment (Zhu and Sarkis 2004). Moreover, it earns the enterprise some ecological, but also economic, added value (Ravi and Shankar 2005; Murphy and Poist 2010). Almost half of SMEs currently operating in the market enable customers to claim faulty products (47%) and provide them with an opportunity to return unintentionally purchased products (35%). Claiming faulty products within their warranty is regulated by the legislature, which increases the proportion of those enterprises that provide their customers with this service.

Table 5. Pareto Analysis of Reverse Logistics Activities

Responses				
Activities of reverse logistics	**Total number**	**Percentage (%)**	**Cumulative percentage (%)**	**Percentage of cases (%)**
Returnable packaging	378	16.9	16.9	74.4
Choice of transport while considering pollution	348	15.5	32.4	68.5
Decreasing material demands for production	341	15.2	47.6	67.1
Recycling products and packaging	303	13.5	61.1	59.6
Product claims	239	10.7	71.8	47.0
Product adjustments	200	8.9	80.7	39.4
Returning unintentionally purchased products	178	7.9	88.7	35.0
Monitoring air pollution and noise	154	6.9	95.5	30.3
Sale of unsold seasonal goods	100	4.5	100.0	19.7
Total	2.241	100.0		441.2

A surprising fact is that the addressed enterprises have indicated the following as the least important activities of reverse logistics: monitoring air and noise pollution caused by transportation and traffic, and selling the unsold (seasonal) goods in specialized stores. The shortest return on invested resources is most often ensured by the least costly measures, *e.g.*, optimizing the use of transportation by means of measurement and regulation in the individual objects and plants. Monitoring air pollution and noise caused by traffic is essential for identifying the core of the problem, as well as its cause.

Increasing awareness of environmental problems and its protection creates a new competitive arena for enterprises, which are forced to include the questions of environmental protection and improvement in their corporate agenda. The government has no less influence on an enterprise, along with the other stakeholders, by requiring that all activities be in accordance with the regulations and thus lower their impact on the environment (Mollenkopf *et al.* 2010). With respect to the growing importance of this problem, motivation is an essential factor in the sustainability of an enterprise. Question B5 reveals the motives that would lead enterprises to applying green logistics in their operations. The respondents could choose from the options which are listed in Table 6. The Friedman test confirmed that not all options are of the same significance for wood-processing SMEs in Slovakia (p-value < 0,001). The Wilcoxon signed test indicated that the most important fact that would motivate enterprises to implement green logistics in their operations is reducing the costs of the enterprise. Another motive, of almost the same importance, is improving the name/image of the enterprise. The least important motives in application of GL in an enterprise were found to be a reduction of the suppliers' costs, and lower consumption of material and energies. This is a very interesting finding because if an enterprise implements new modern technologies, which reduce the demands for energy and material in its production process, it will mean economizing on operational costs. Lower consumption of material can mean cheaper products for final consumers. Lower prices and the right promotion of a new, more ecological, product opens up new market opportunities for the enterprise and thus contributes to higher profit. Ecological investment

requires costs, and an enterprise that invests in this field expects certain, directly calculable, profit. When implementing green activities, savings or additional revenues may show in different areas, and only long-term. In these conditions, corporate subjects tend to resist ecological investments. It is therefore necessary for the government and society to put pressure on the enterprises that enables these investments to be made.

Question B5 was connected with evaluation of hypothesis H_2, which assumed that in the practice of wood-processing SMEs in Slovakia, the most important benefit of implementing green logistics activities is reduction of costs. The Wilcoxon signed test confirmed this assumption, while reducing costs was evaluated as the most significant benefit (Table 6). Hypothesis H_2 was accepted. Pareto analysis also proved this benefit to be the most significant, as it was chosen by 67.9% of the addressed enterprises.

Table 6. Wilcoxon Sign Test Evaluating H_2

	B5i - B5c	B5f - B5i	B5k - B5f	B5o - B5k	B5e - B5o	B5m- B5e	B5h- B5m
Z	-8.851a	-3.046a	-1.945a	-1.290a	-0.069a	-0.697a	-0.941a
Asymp. Sig. (2-tailed)	0.000	0.002	0.052	0.197	0.945	0.486	0.347
	B5a - B5h	B5j - B5a	B5g - B5j	B5d - B5g	B5n - B5d	B5b - B5n	B5l - B5b
Z	-0.305a	-0.836a	-1.546a	-0.171a	-0.870a	-2.488a	-1.877b
Asymp. Sig. (2-tailed)	0.760	0.403	0.122	0.864	0.384	0.013	0.060

a. Based on positive ranks. b. Based on negative ranks. Wilcoxon signed ranks test

a. reducing customers' costs;
b. reducing suppliers' costs;
c. reducing the costs of the enterprise;
d. improving customer relations;
e. improving customer service;
f. increasing competitiveness;
g. increasing the return;
h. reducing the business risk;
i. improving the name/image of the enterprise;
j. increasing the profit of the enterprise;
k. reducing emissions and waste;
l. lower consumption of materials and energies;
m. managerial skills and enthusiasm;
n. government support;
o. improving public relations and relations with state institutions.

Management of an enterprise evaluates the pros and cons related to planned changes within the enterprise. Within the process of planning, or even sooner, *e.g.*, during the process of considering if the enterprise should implement green logistics activities, management can encounter various barriers that discourage them from applying the chosen activities in their processes. The attitudes of our respondents toward the individual barriers of implementing green logistics activities in their enterprise were examined by question B6. The Friedman test found that wood-processing SMEs do not assign the same level of importance to the given barriers in the questionnaire (p-value < 0.001). The Wilcoxon test

(Table 7) confirmed that the most significant barrier to implementing the green logistics activities in an enterprise appears to be the high input costs (p-value < 0.001), followed by the lack of financial resources in the enterprise and the lack of support from the government (p-value = 0.769). The weakest barrier, as identified by the respondents, is the lack of interest of customers, lack of employees qualified in the field of GL, restricted access to technologies reducing the negative impact of business activities on the environment, lack of interest of the enterprises, and insufficient support of distributors and suppliers.

Table 7. Wilcoxon Sign Test Evaluating Question B6

	B6d - B6a	B6h - B6d	B6f - B6h	B6b - B6f	B6c - B6b
Z	-17.000a	-0.294a	-2.892a	-1.208a	-4.205a
Asymp. Sig. (2-tailed)	0.000	0.769	0.004	0.227	0.000
	B6g - B6c	B6e - B6g	B6k - B6e	B6j - B6k	B6i - B6j
Z	-2.031a	-0.884a	-1.272a	-0.780a	-0.359a
Asymp. Sig. (2-tailed)	0.042	0.377	0.203	0.435	0.719
a. Based on positive ranks. b. Wilcoxon signed ranks test					

a. high input investment costs;
b. uncertain return of the investment;
c. high operational costs;
d. lack of financial resources;
e. lack of workforce qualified in the field of GL;
f. lack of knowledge of GL;
g. lack of interest on customers' side;
h. lack of state/government support;
i. insufficient support of distributors and suppliers;
j. lack of interest of SMEs;
k. restricted access to technologies which reduce the negative impact of business activities on the environment

According to Orsato (2006), the laws and regulations concerning protection of the environment form an important frame, which the enterprises must follow and adjust to. Lack of governmental support is one of the most significant barriers to implementation of green activities, which has been confirmed by the results of various research articles (Alkhidir and Zailani 2009; Monson 2014; Duan 2015). What the researchers also found was that SMEs lack sufficient knowledge of green logistics, which was indicated as a barrier to its implementation (Boiral 2007; Shibi and Eglese 2009).

Hypothesis H_3, which assumes that the largest barrier to implementing the green logistics activities in wood-processing SMEs in Slovakia is high investment costs, was related to question B6. The Wilcoxon sign test confirmed this hypothesis, as high investment costs were marked as the largest barrier by our respondents (Table 8). Several researchers (Hillary 2000; Alkhidir and Zailani 2009; Mollenkopf *et al.* 2010) confirm that lack of financial resources and long-term return of the investments are the most significant barriers to implementing green logistics activities in an enterprise.

Our respondents also provided an explanation as to why the implementation of green logistics activities may be problematic. The most commonly suggested reason was a

highly unstable program of goals of an enterprise to quickly satisfy the needs of a customer, regardless of the costs, only not to lose a deal that is essential for the survival of the enterprise. In such conditions, it is difficult to optimize transportation or supplies. Separation of waste is perceived as being only a secondary solution to problems that, theoretically, may not even have occurred. In this case, even an environmentally motivated manager faces a dilemma. Financial resources that are spent on complete and immediate satisfaction of a customer limit investments in green technologies and research and development, which could increase the effectivity of the enterprise and achieve full savings. The current situation in wood-processing SMEs that implement survival strategies in their business practice results in lack of interest in implementing, or spreading the knowledge related to, green logistics.

The conducted empirical study confirmed the results of research (D'Souza *et al.* 2006) stating that SMEs must pay more attention to added environmental value (voluntary environmental activities exceeding the legislative obligations of the enterprise), which brings in not only better protection of the environment, but also an increased competitive advantage for those SMEs that decide to take this route, *e.g.*, by the increased demand for performance of an environmentally conscious enterprise on the customers' side.

Proposed Model for Ensuring Sustainable Development of Slovak Wood-Processing SMEs by Implementation of Green Logistics Activities

One of the main impulses for implementing the initiatives of green logistics in SMEs is pressure from the stakeholders. Furthermore, what is very important is the involvement of the management because it directly influences how well these initiatives will be accepted by the employees of the enterprise, who, at the same time, are the main executors of these activities (Faletar *et al.* 2016). Based on the research results and the analysis of secondary sources, a framework for a standardized model of implementing green logistics activities in Slovak wood-processing SMEs is proposed, including the appropriate activities ensuring the sustainable development of SMEs, which consist of six basic steps. The model is founded on the principles of environmental and social responsibility, as well as the initiative and voluntary principles.

Among the most essential steps to be taken is the commitment of the management to implement the GL activities and communicating it to stakeholders. The enterprises define their environmental policy in formal documentation, ensure its implementation and evaluation, and make it available to the public. The content of the environmental policy should focus on prevention rather than correction, and move the focus from removing the consequences of harming the environment to removing its causes. By the appropriate formulation of the environmental policy, wood-processing SMEs may decrease the negative impact of the identified barriers.

The following step of the proposed algorithm of implementing green logistics is the analysis of the external and internal environment. The research in Slovak wood-processing SMEs confirmed that the basic barriers to implementation of green logistics activities are not only the financial and economic factors, but also the perception of stakeholders, who on the one hand expect these initiatives, but on the other, are not willing to finance them. Also, their requirements related to this aspect are unclear and incomprehensible, and often beyond the possibilities of SMEs (Lee and Klassen 2008). The result of the external analysis is the identification of external risks that can affect the wood-processing enterprise when implementing GL activities. If correct results are obtained, this enables decreasing the analyzed barriers g, h, i, and j. Following this, the internal analysis of the opportunities

of wood-processing SMEs is performed, related to providing new services in the given field, which differentiates the enterprises from their competitors. The research revealed that wood-processing SMEs see the biggest barriers of implementing green solutions in the resources of the enterprise (evaluation of question B6). Communication and cooperation among departments whose activities and outputs are related is of no less importance. If correct results of the internal analysis are obtained, it leads to decreasing the analyzed barriers d, e, f, and k.

As the following step of the implementation, based on the findings resulting from the internal and the external audits of the enterprise and its comparison, the identification of the enterprise's opportunities for improvement was proposed. At the same time, an attempt was made to answer the question of how the implementation of the selected green logistics initiatives will reflect in the price offer of wood-processing SMEs. Our research has confirmed that wood-processing enterprises in Slovakia mostly engage in activities related to reverse logistics; however, it is the innovative activities of green logistics that will represent the driving force for the next generation of enterprises that wish to remain competitive and sustainable. By choosing the appropriate GL activities, wood-processing SMEs reduces the risk of the impact of barriers a, b, and c.

If an enterprise is interested in implementing GL initiatives, the next step must be ensuring the organizational support and suitable human resources. It is essential to raise the employees' awareness, and improve their environmental knowledge. At the same time, it is important to plan a green direction for all resources in an enterprise, which is inevitable for fulfilling the objectives of green logistics. This measure reduces the impact of barriers d, e, f, and k.

The previous steps are followed by the implementation of selected activities in the enterprise. In this step, a strong inclination was expressed toward an opinion that within green procurement, it is important to focus on such activities that are oriented towards reduction, reuse, and recycling of materials in the procurement stage (Hillary 2000). This is the choice of green suppliers, who offer ecologically safe inputs (recyclable, with low content of hazardous substances, having a green certificate). In the process of procurement, recycled material is used, *i.e.*, such material that can be reused (*e.g.*, office paper). Email and telephone are used to place orders. Green production uses inputs that have a low negative impact on the environment (Murphy and Poist 2010; Bergman 2012). These include using waste water, reducing the amount of hazardous substances, decreasing energy consumption, prolonging the lifecycle of a product, improving availability of technology, proposing new eco products, reducing the amount of waste (by recycling or reusing materials), and decreasing the amount of inputs. A sustainable distribution strategy should be based on appropriate localization and character of the distribution channels and should also include reverse distribution channels. When distributing products to customers, enterprises should take account of means of transport that have lower demands for the environment. The following statement can thus be accepted: to build a communication strategy for customers, with respect to responsibility, it is essential to familiarize them with all green logistics activities that the enterprises are implementing in their business practices (Mosgaard 2015).

Another step of the implementation is the evaluation of the environmental behavior of an enterprise. With respect to the standard ISO 14031 (2013), it is suggested that an enterprise monitor the indicators related to management of environmental activities (MEI – management environmental indicators), indicators used to measure environmental aspects of production and operational activities (OEI – operational environmental

indicators), and indicators that measure conditions of the environment in the immediate vicinity of the monitored enterprise (ECI – environmental condition indicators). Most enterprises use OEI, knowing that managing the environmental aspects will reduce their environmental impact. If an enterprise chooses the appropriate indicators, it ensures an objective feedback, which enables the enterprise to decrease the negative impact of all identified barriers.

At present, there is no written algorithm for implementing green logistics activities in wood-processing SMEs in Slovakia. This proposed algorithm contains seven basic steps, where the last step is feedback. During the feedback stage, the enterprise identifies if it has achieved its environmental goals based on the outputs of the evaluation of its environmental behavior. Results of various studies (Shibi and Eglese 2009; Dekker *et al.* 2012) have confirmed that within feedback, it is important for the enterprise to make sure that the planned green solutions are being implemented and are a part of everyday logistics activities.

Implementing this algorithm can help managers to identify which green logistics activities in the enterprise they need to focus on and which are less important, as well as how to allocate the limited resources of an enterprise.

CONCLUSIONS

1. Based on the analysis of the theoretical foundations of the given problem, and on the results of our research, a frame of a standardized model of implementing the green logistics activities in wood-processing SMEs was proposed, partially modifiable while taking into account the specifics of the given enterprise. If the model is implemented appropriately, it reduces the negative impact of identified barriers, and enhances the identified advantages. The main objective of the research has been achieved.
2. Our research has found how wood-processing SMEs in Slovakia perceive the green logistics activities and has identified factors that lead these enterprises to their implementation. The addressed enterprises expressed the strongest agreement with the statements that green logistics involves the following: use of environmentally friendly packaging, ecological way of transporting materials and goods, and ecologically appropriate waste management.
3. Consistent with hypothesis H_0, the results of our research revealed that more than one third of our respondents have encountered green logistics activities in their enterprise, while less than one fourth define these activities in their corporate documentation and require their full or partial fulfillment from their employees. Hypothesis H_0 was rejected. At the same time, in parallel with hypothesis H_1, the research disclosed that less than half of the addressed enterprises have already implemented at least five green logistics activities. Therefore, hypothesis H_1 was rejected. Nearly two thirds of wood-processing SMEs are already implementing, or plan to implement, the following green logistics activities in a short time: separating and recycling waste, using electronic invoicing, effective loading of transported goods, ecological office, optimization of transportation routes, reducing the amount of packaging, efficient way of driving, and using means of transportation that are environmentally friendly.

4. In line with hypothesis H_2, the research revealed that among the main advantages of implementing GL activities in wood processing SMEs are: reduction of costs, improving of corporate image, increasing a company's competitiveness, reduced emissions, improved relations with public and state institutions, as well as customer service, managerial skills, and the motivation of managers for ecological questions, and finally if they decreased the business risks and the costs for the customer. Cost reduction was evaluated as the most significant benefit. Hypothesis H_2 was accepted.
5. Finally, consistent with hypothesis H_3, the research revealed that wood processing SMEs which participated in the present research consider the following to be the biggest barriers: high input costs, lack of financial resources, lack of state support, lack of knowledge of green logistics, uncertain return on the investments, and high operational costs. The results of our research confirmed hypothesis H_3.
6. Summary of the research results leads to formulating the following conclusions: the most significant benefit of implementing the green logistics activities in wood-processing SMEs is reduction of costs; and understanding the problem of implementing green logistics activities in business practice is generally at a high level in Slovak wood-processing SMEs.
7. Innovations in green logistics represent a great potential in strategic planning and sustainable development, particularly for SMEs, which play a significant role in the wood-processing sector and are considered to be the 'backbone' of the economy because of their number and position.

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