

# POSSIBILITIES OF REVERSE MATERIAL FLOWS SOLUTION

## MOŽNOSTI RIEŠENIA SPÄTNÝCH MATERIÁLOVÝCH TOKOV

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### **Abstract**

The paper deals with the problem of reverse material flows in the production enterprise. The main accent is on the use of wastes from the production process and their reverse use in the production process.

### **Abstrakt**

Príspevok sa zaoberá problematikou spätných materiálových tokov vo výrobnjej spoločnosti. Hlavný dôraz sa kladie na využitie odpadov z výrobného procesu a ich spätné využitie vo výrobnom procese.

### **Key words**

Material Flow, Reverse Material Flow, Waste

### **Kľúčové slová**

Materiálový tok, spätný materiálový tok, odpad

## **INTRODUCTION**

Waste presents an unwanted part of production in every enterprise. There are many ways how to achieve elimination of wastes from the enterprise. But, in recent time, enterprises perceive the waste as a something “positive” because it can bring profit for enterprise. Some commodities of wastes can save funds by the right solution and liquidation or it can present the source of incomes. One of the suitable way how to effectively use wastes is their recycling. The basic idea of recycling is “based on” reverse material flows and reverse logistics.

## **BACKWARD (OR REVERSE) MATERIAL FLOW AND REVERSE LOGISTICS**

Logistics management emphasizes the management of raw materials, supplies flows in the production and also finished products and it ensures the effectiveness of this management (Malindžák et al., 2007). Therefore, for the overall logistics process the material flow and its following management is very important. It is also important the management of material flow from the point of its creation to the point of consumption (Sixta – Žižka, 2009). It can happen the situation when the material in the logistics chain does not flow from the supplier of raw materials by the producer to the consumer, i.e. “by the flow”, but there is a reverse flow. It gains importance in the field of reverse logistics. This flow is created on the one hand by waste, which can be recycled and partially returns to the next use like a secondary raw material, or it can be created by goods under complaint or returned products or products which finished their lifetime. The other part of reverse flows are presented by returnable containers. All these part created a new, important logistics subsystem, namely reverse logistics (Brezina et al., 2009). Reverse

logistics is a part of eco-logistics and it deals with control, support and realization of reverse flows of raw materials, materials in collecting networks at the direction from customers to the point of processing (Husáková, 2015). Evidence of reverse logistics importance is possible to see in the loss of profit for enterprise which are not able to operate with reverse flows and are not prepared to implement reverse logistics into its own management. Implementation of reverse logistics in all sectors of the industry can be follow in the supply chain (Brezina et al., 2009).

## **POSSIBILITIES OF REVERSE MATERIAL FLOW SOLUTION IN THE SPECIFIC ENTERPRISE**

Possibilities of reverse material flow solution were examined by the help of the case study which was realized by the researchers of the Institute of Logistics (Faculty BERG, TU Košice) in the specific enterprise dealing with production of printers, sensors, scanners etc. The enterprise produces various wastes, but the majority part is presented by plastic wastes. The plastic creates more than 60% of the total volume of wastes in this enterprise. This plastic waste is produced at the department of plastic pressroom and by reason of its volume it presents the subject of interest in the enterprise. For recycling are suitable three types of these plastic wastes. The table 1 presents these types of wastes, their yearly “production” and the price of these wastes per 1 kg.

Table 1 Types of plastics wastes suitable for recycling in the researched enterprise

Type of plastic waste	Yearly “production” [kg/year]	Price for kg [Eur]
DELIRIN 500P NAT.NC10	7817,05	2
TERLURAN GP-22 SCH	2015,96	3
ULTRAMID 4355 G5 Natural	3689,24	3

Source: author

### **Analysis of market oriented to the recycling devices**

For the researched enterprise was very important to select a suitable recycling technology for wastes and secondary raw materials processes. Therefore, by the case study we realized a market analysis oriented to these technologies. From the results of this analysis we obtained the summary in the way of knife mills. Knife mills are suitable devices for wastes granulation which have single-sortal character. It is a device which ensures that the output form of the plastic waste has required and right form (by the researched enterprise plastic re-granulate) [18].

### **Selection of the suitable device for the recycling process**

For implementation of recycling process to the production at the department of plastic pressroom, it was needed to select suitable technological device by the demands of the enterprise. For this selection was by the case study applied two methods of multi criteria decision making, namely Saaty`s method and method of paired comparison. These methods

were applied also by evaluation of partial utility of variants by the selected criteria. For the selection of suitable variant six criteria were defined. These criteria describe properties of devices. These criteria were the subject of consultation with three employees of the researched enterprise (from the department of quality, logistics and plastic production). Table 2 present the determined criteria for the next solution by the case study. We must emphasize that the partial calculations (comparison of criteria by the selected methods, evaluation of criteria, calculation of the normed scales of criteria, determination of the partial utility by the criteria) are not included in this paper in the results of their extensiveness.

Table 2 Evaluation criteria for the selection of suitable variant

Criteria	Variant No. 1 Knife mill G150/240	Variant No. 2 Knife mill C 17.31	Variant No. 3 Knife mill SG 1628 N
A: Output [kg/h]	15 – 50	25-30	50
B: Fastidiousness of operation	simple	simple	more exacting
C: Equipment	screens	screens	screens
D: Input mouth	197x400 mm <sup>2</sup>	170x310 mm <sup>2</sup>	385x400 mm <sup>2</sup>
E: Service	2	3	1
F: Acquisition price	4600 EUR	3300 EUR	5050 EUR

Source: author

### Calculation of the total utility by the selected methods

For selection of the suitable variant it is needed to calculate the total utility of each variant. The calculations of the normed scales of criteria for knife mills were noticed in the total table of utility also as the normed scales of partial utility for each variant by the defined criteria. This information was needed for realization of calculation for selection of suitable recycling device at the department of plastic pressroom.

From the calculations obtained by Saaty's method it is evident that the suitable device for this purpose is presented by the variant No. 2, that means, that from the possibilities it was selected the knife mill C 17.31 (by the company Wanner). Table 3 presents the total calculation.

Tab. 3 Calculation of total utility for recycling devices by Saaty's method

Criterion	Variants Scale of the the criterion	Variant No. 1		Variant No. 2		Variant No. 3	
		Utility		Utility		Utility	
A	0,149	0,623	0,093	0,239	0,036	0,138	0,021
B	0,083	0,283	0,023	0,648	0,054	0,074	0,006
C	0,027	0,107	0,003	0,260	0,007	0,633	0,017
D	0,251	0,260	0,056	0,633	0,159	0,107	0,027
E	0,047	0,072	0,003	0,696	0,033	0,232	0,011
F	0,443	0,379	0,168	0,278	0,124	0,343	0,152
Total utility	1	Σ	0,346	Σ	<b>0,413</b>	Σ	0,234

Source: author, own calculation

For precision of the results it was applied the calculation of the total utility of the devices by the method of paired comparison. This method acknowledge that the variant No. 2 is suitable

for the processing of plastic waste at the department of plastic production. The calculation of the total utility by the method of paired comparison is presented by the Table 4.

Table 4 Calculation of the total utility for the evaluated recycling devices by the method of paired comparison

Criterion	Variants	Variant No. 1		Variant No. 2		Variant No. 3	
		Scale of the criterion	Utility	Utility	Utility	Utility	Utility
A	0,190	0,667	0,128	0,333	0,063	0,000	0,000
B	0,143	0,333	0,048	0,667	0,095	0,000	0,000
C	0,048	0,000	0,000	0,667	0,032	0,333	0,016
D	0,238	0,333	0,079	0,667	0,159	0,000	0,000
E	0,095	0,000	0,000	0,667	0,063	0,333	0,032
F	0,286	0,000	0,000	0,667	0,191	0,333	0,095
Total utility	1	Σ	0,225	Σ	<b>0,603</b>	Σ	0,143

Source: author, own calculation

### SUMMARY OF RESULTS OF BOTH USED METHODS

Results of the calculations of both applied methods were summarized in the Table 5, which presents the total utility of the selected variants. By this table, it is evident, that the variant No. 2 is the best in comparison with the selected variants, namely in the case of both methods.

Table 5 Comparison of the results of used methods

Partial utility	SM	MPC
V1	0,346	0,000
<b>V2</b>	<b>0,413</b>	<b>0,032</b>
V3	0,234	0,095

Source: author, own calculation

### RESULTS AND DISCUSSION

After the analysis of the plastic wastes production at the department of plastic pressroom we obtained the following results:

- definition of the plastic wastes at the department of plastic pressroom;
- definition of plastics production at the department of plastic pressroom and creation of the scheme;
- definition of the current way of plastic wastes elimination from the department of plastic pressroom, this is presented by sale of plastic wastes;
- design of new way of plastic wastes elimination at the researched department, by application of recycling at the department of plastic pressroom and implementation of the recycling process to the scheme of wastes production at this department.

Subsequently, it was realized a market analysis aimed at recycling devices, and by this way it was selected the solution, which is presented by three ways of recycling solution:

- knife mill G 150/240,
- knife mill C 17:32;
- knife mill 1628 N. SG.

After the market analysis for recycling devices were selected two methods of multi criteria decision making, by which it was selected the suitable variant of solution, namely Saaty's method and method of paired comparison. After the calculation, it was found that the suitable recycling device for this department of plastic production is the variant No. 2, namely the knife mill of the company Wanner (type 17:31).

## CONCLUSION

We can say that reverse logistics is a part of enterprise management. This example was also in the researched enterprise. By the help of the case study it was research the department of plastic pressroom with the definition of the produced wastes, above all plastic wastes. The first step of solution for reverse material flow in this enterprise was the design of the scheme for reverse material flows with the repeated "implementation" of plastic wastes to production process. The designed solution also includes the selection of suitable recycling device for implementation of recycling. For this solution it was realized the market analysis and by the help of consultation with the enterprise it was selected knife mills from three companies. For their comparison were used two methods, namely Saaty's method and method of paired comparison. These methods were used for precision of results, namely by comparison of results of these methods. After the calculation it was determined that the suitable variant for implementation of recycling process is application of knife mill by the company Wanner (type C 17.31). By implementation of the recycling process at the department of plastic production, the production provides suitable re-granulate for own purpose.

## LITERATURE

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