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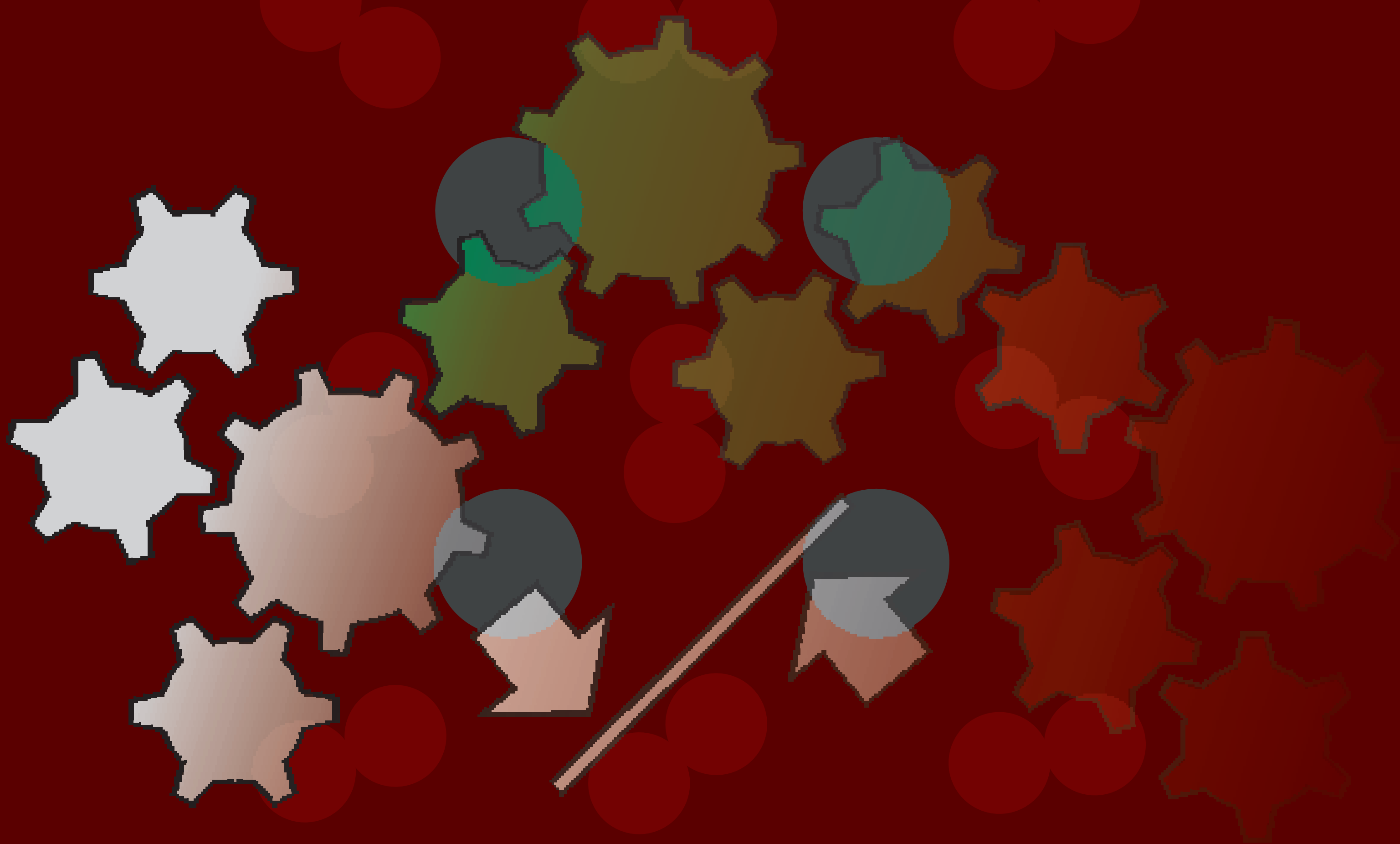

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EVALUATION OF THE IMPACT OF INTELLIGENT LOGISTICS ELEMENTS ON THE EFFICIENCY OF FUNCTIONING INTERNAL LOGISTICS PROCESSES

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Keywords: logistics evaluation, logistics efficiency, intelligent logistics

Abstract: The article focuses on the evaluation of the impact of intelligent logistics elements on the overall efficiency of logistics processes. The main goal is to propose the concept of evaluation of changes in the logistics process, which will provide transparent results in the decision making process. Logistics activities represent a significant component of business costs, especially in the engineering and automotive industries, and it is therefore important to pay attention to both innovation and optimization. The implementation of intelligent elements in the field of logistics brings changes that will influence the entire logistics process. The article describes the sequence of steps as well as the methods used to evaluate the changes. Knowing the added value of planned changes will help prevent inappropriate investment and ensure the competitiveness of the company.

1 Introduction

To gain an added value of a new internal intelligent logistics process solution, it is important to take a comprehensive approach to the overall evaluation process. The use of intelligent elements such as autonomous storage devices, autonomous handling equipment or autonomous storage systems provides scope for streamlining logistics processes. The implementation of such logistic elements entails considerable financial costs, both in terms of technology, space and organization. The process of evaluating a new logistics process solution is shown in Figure 1, which describes basic steps in evaluating a new solution. In order to evaluate a new design or change the internal logistics process or several logistic processes, it is necessary to thoroughly map or analyse the initial state of internal logistics processes by utilizing process audit methods such as process map, process analysis, process time frames, etc. In analysing the current state of logistics processes, in addition to the process mapping of logistics processes, an analysis of the logistics elements used is also needed, which are made up of technical and technological elements such as various handling equipment used for material handling. After obtaining an image of the current state of the individual logistics processes and the detection of drawbacks or shortcomings, a second step is coming up, namely designing solutions to optimize logistics processes. When choosing new logistics elements, the company must be able to decide what should be their beneficial outcome. In such a case, when more criteria need to be considered in the decision-making process, it is necessary to use multi-criteria decision-making methods such as the AHP statistical method. If one or more logistics elements were selected, it is important to be able to calculate and then express their contribution to the logistics process. The step of evaluating the impact of the change in the logistics process brought about by the change of logistics elements comes to the fore. The logistics process efficiency assessment within the logistics process can be performed using, for example, a matrix model of logistic process evaluation or a mathematical model evaluating the logistical process change efficiency.

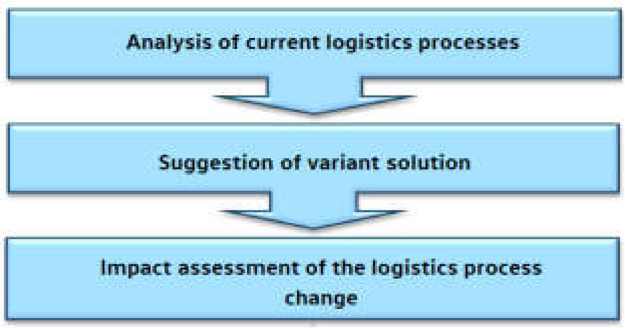

Figure 1 Intelligent Logistics Impact Assessment Concept

2 Analysis of current logistic processes and evaluation of logistic indicators

The first part of the evaluation concept is the analysis of current logistic processes. The evaluation of logistics indicators within integrated logistics chains is a prerequisite for achieving the set logistics goals [1]. Because properly designed logistical indicators and a functional assessment system have significant cognitive, assessment and motivational functions, and provide essential information relevant to logistical decision-making. Thus, exploiting the results from the analysis of the data obtained becomes an essential tool for determining both overall and sub-goals within the logistics chain. The integration of the logistics indicator evaluation system within the logistics processes represents the company's protective mechanism against the occurrence or increase of the problems of the existing logistics chains [2].

3 Solution variant proposal

The second part of the proposed evaluation concept is a proposal for a solution variant. All day-to-day activities that a person does, either consciously or subconsciously, are the result of some decision-making process. In the case of activities we do consciously, we try to get as much information as possible about the problem. We then use this information to achieve the best possible result. If more variations or alternatives are available and we cannot decide which of the variations we achieve the greatest benefit, it is necessary to divide the solution object into a clear structure and on the smallest possible elements. Thus, we need a tool that is able to work in parallel with multiple variations based on established criteria. If this problem is identified, we recommend that you determine in this section:

- the decision-making goal to remove the identified problem. Often the objective consists of several sub-goals that serve to reduce the proposed options,
- criteria that will be used to decide, in other words, the assessment aspect used to select the most appropriate option to solve the problem,
- the solution to the problem. These are alternatives that compared each other on the basis of established criteria to meet a set goal.

Such an instrument is, for example, the AHP method - an analytical hierarchical process that is widely used as a multi-criteria decision-making method [3]. AHP serves to break down the whole problem into hierarchies and then to compare the two elements by which we get the criteria weights and partial evaluations of alternatives. The overall evaluation is then obtained by simple synthesis [4]. The use of this method can be supported by software support using the Expert Choice program.

We recommend following the sequence of phases shown in the following figure no. 2 [5]:

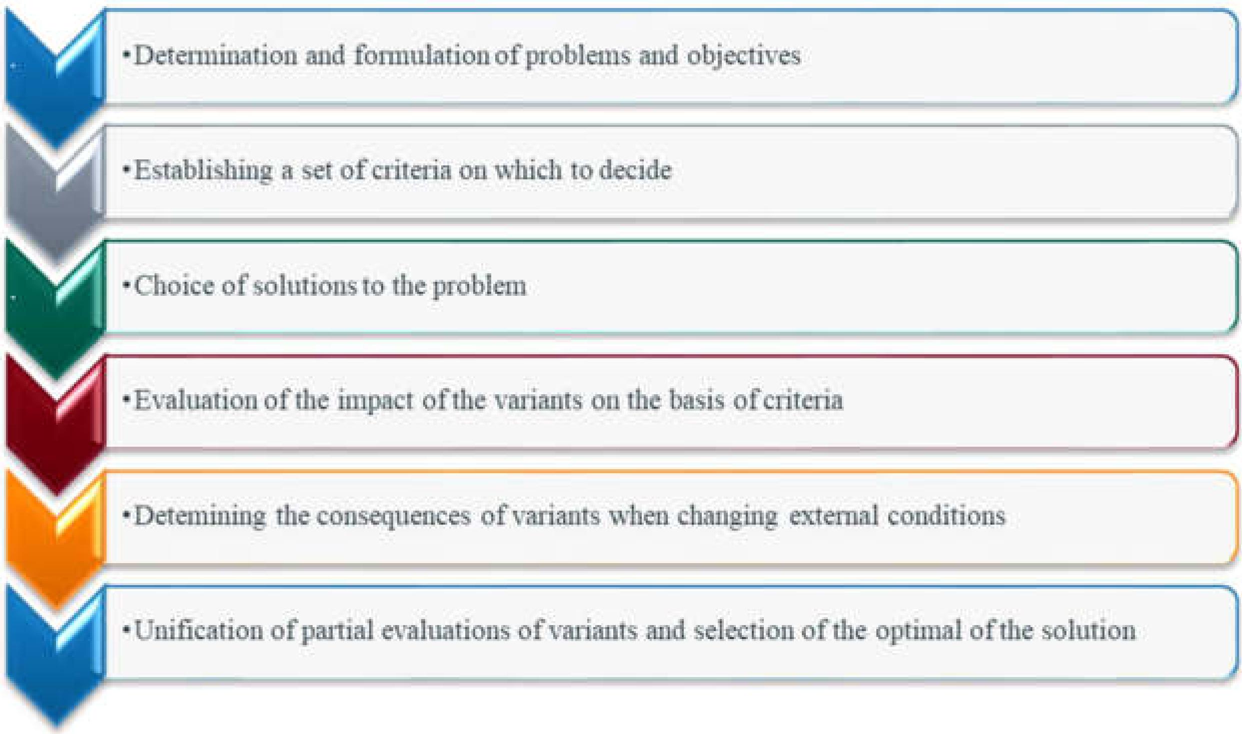

Figure 1 Stages of multi-criteria evaluation

4 Impact assessment of logistical process change

The third and last part of the proposed concept is the assessment of the impact of the change in the logistics process. In this section there is an overall evaluation of the activities of the previous two parts of the proposal. Thus, if we have analysed the current state of business logistics processes, we have defined weaknesses or problems that need to be removed and we have selected options that are supposed to eliminate the defined problems, comes the last step and that is to evaluate the proposed changes to the logistics process. This process is cyclic, meaning that it is performed separately for each proposed variant and is made up of three basic steps as shown in Figure 3 below.

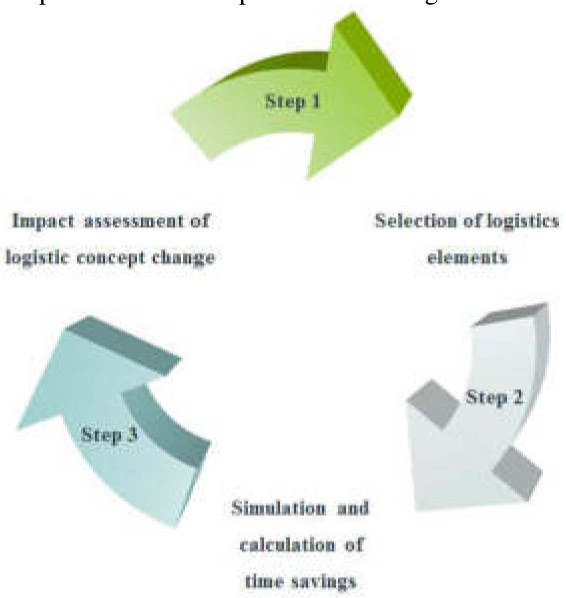

Figure 2 Procedure to evaluate the change of the logistics process

The first step in assessing the impact of the new internal logistics process is to select logistics elements. The choice of logistics elements consists of two parts. The first part consists of the logistics elements used in the company in the field of internal logistics for transport, handling and storage, and the second part consists of selected logistics elements, which were designed as elements with expected savings of, for example, the time of supply of material through the multi-criteria decision method. Savings in logistics processes are most often expressed in time, financial or cost units. Saving time in logistics processes means that an enterprise is able to meet customer needs in a shorter time, making it more flexible and capable of performing more logistical tasks per unit of time. Cost savings are one of the fundamental goals of any company, and since logistics as such accounts for a significant proportion of total business costs, it is important that logistical costs are of interest to any optimization of logistics processes.

The second step in the process of optimizing internal logistics processes after selecting suitable logistics elements is to include the step of simulation and calculation of the proposed solution. Various techniques are used in simulation and calculations, and it is important to know all the parameters of the individual elements of the proposed solution. We recommend performing individual simulations either through software support or through mathematical models or computational methods or statistical methods such as MTM. The MTM methodology, including its several blocks (MTM-1, MTM UAS, MTM Logistics), is a method that works with predefined times for each workflow that is used to design workflows, plan and analyse work done so that a trained worker can perform a given workflow long-term activity without excessive fatigue.

In the third step to express a concrete contribution, we propose to include an impact assessment of the change in the logistics concept. Assessing the impact of a change in the logistics process by proposing a new concept within the design of the implementation of new logistics elements serves to express the usefulness of the change to the previous solution. This process is cyclical and therefore is carried out whenever one or more logistics elements are changed in order to find the optimal solution to change the logistics process.

We recommend using several computational models such as a matrix model of logistics efficiency evaluation or a mathematical model of efficiency evaluation changes in the logistics process.

The use of a mathematical model to evaluate the efficiency of change in the logistics process is very simple compared to the matrix model and we recommend using it in every change within the logistics chain. The calculation is based on the following values [2]:

- *Hp* – represents the value that a customer is willing to pay for a given product or product service,
- *Cp* – determines the total running time of the given service or service. delivery of the product to the customer,
- *Np* – represents the total costs incurred to carry out the given activity.

The resulting logistics process change efficiency relationship (1) is as follows [2]:

$$\Delta Np / \Delta Cp < Zp / Cp \qquad (1)$$

- ΔNp – expresses the difference between the increased costs that a new variant brings with respect to the original logistics process.
- ΔCp – expresses the time difference between the execution of the given logistics activities between the original state and the state proposed by the change of logistic elements.

The mathematical model (2) also brings with it several conditions, such as the condition of the efficiency of the change in the activity of the logistics process, where the proposed change in logistic activity must show a greater profit generation rate (*Ip*) than the original process that we calculate by the following relationship [2]:

$$Ip = Zp / Cp \qquad (2)$$

The second important condition in assessing the efficiency of a change in the logistics process is that the proposed change in the logistics process must show a positive time saving by ΔCp.

5 Conclusion

The process of streamlining logistics processes itself is a constantly repeating cycle that provides companies with space for increasing their competitive advantage in rapidly changing market conditions and increase of demanding customer requirements. The aim is to point out the necessity of monitoring and evaluation of individual logistic indicators at every change of logistic process. Each logistics process consists of a number of logistics elements, each of which in a certain way contributes to the resulting efficiency. Assessing the impact of changes in the logistics process when changing its elements therefore plays a very important role in planning for changes in the logistics process. By following the logistics indicators, by identifying the right criteria for the new active logistics elements used in the change of the logistics process, the basic data is generated to evaluate the proposed changes in the logistics system and thus create an efficient logistics system. The result of the evaluation concept is the creation of a comprehensive procedure for the evaluation of the impact of intelligent logistics elements on the efficiency of internal logistics processes, from the analysis of the current state through the design of solution variants to comparison and subsequent evaluation of each variant with one another.

References

[1] VIDOVA, H.: *Logistikcs controlling*, Bratislava: STU, No. 1, pp. 89, 2009. (Original in Slovak)
[2] CIBULKA, V.: *Logistics source of efficiency, productivity and market performance of the company*, Trenčín: TnUAD, No. 1, pp. 232, 2015. (Original in Slovak)
[3] BAĎO, R., VRABLIC, P.: *Utilization of multiriterial decision making by AHP method in decision making in business*, [Online], Available: http://www.sjf.tuke.sk/transferinovacii/pages/archiv/transfer/21-2011/pdf/082-085.pdf, [15 May 2018], 2011. (Original in Slovak)
[4] ROHÁČOVÁ, I., MARKOVÁ, Z.: *Analysis of the AHP method and its potential use in logistics*, [Online], Available: http://actamont.tuke.sk/pdf/2009/n1/15rohacova.pdf, [16 May 2019], 2009. (Original in Slovak)
[5] JANDOVÁ, V.: *AHP – its strengths and weaknesses,* [Online], Available: http://theses.cz/id/5j4i3e/Jandova_-_AHP_Jeji_silne_a_slabe_stranky.pdf, [16 May 2019], 2012. (Original in Slovak)

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THE CONSTRUCTION OF THE FUNCTION OF THE ULTIMATE GOAL OF THE TECHNOLOGICAL PROCESS OF NON-AUTOCLAVED FOAM CONCRETE OBTAINING

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Keywords: technological process, foam concrete, system, multi-factor approach, optimality criterion, calculation experiment
Abstract: This paper presents the method of solving the multicriteria problem of obtaining foam concrete with a required set of properties for each subsystem of the technological process. The General decision algorithm based on usage of lexicographic or "specified" method of purposeful search has been constructed.

1 Introduction – Technological process as a system

The process of non-autoclaved foam concrete obtaining is complex and multifactorial and it must be considered as a technological system that has the main features of complex systems [1,2].

1. Decomposition: the system is divided into a finite number of subsystems, and each subsystem, in turn, into a finite number of simpler subsystems, etc. to get the simplest elements of the system.
2. Subsystem interaction ordering: all elements of a complex system interact with each other and with the external environment.
3. The general property of complex systems is defined as an integral combination of properties and interaction patterns of constituent subsystems.
4. Performance of the main function of the system is achieved by the time-ordered performance of functions by its main elements.
5. A complex system is not stationary. As a rule the processes occurring in it depend on the time factor τ.
6. The system is nonlinear. External disturbances can have a significant effect on the result of the system.
7. The system is highly dependent on the initial conditions.

The presence of all these signs is proof of the possibility of representing the process in the form of a complex technological system "Process of obtaining of non-autoclaved foam concrete", which is divided into subsystems according to time, functioning processes, equipment grouping, etc.

A certain sequence of basic operations in the technological process suggests an obvious relationship between the subsystems. Each subsystem performs its specific work – a process, regardless of the work of other subsystems [1,3]. To ensure the compatibility of work and the integrity of the entire technological system, the results of the previous subsystem should serve as the initial conditions for the subsequent [2,4].

Based on these conditions, the system "Process of non-autoclaved foam concrete obtaining" can be represented in the form of interconnected subsystems corresponding to the main technological operations (figure 1): preparation of raw materials, preparation of form concrete mix and moulding. The last subsystem ends with the receipt of the product with the specified properties.

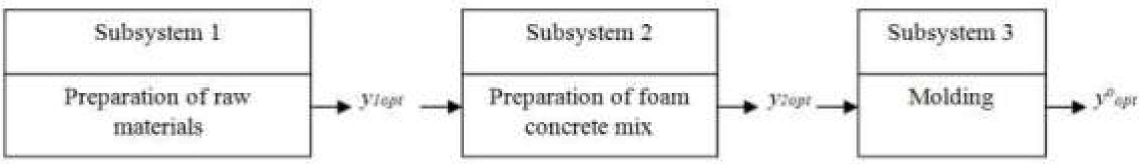

Figure 1 The linear diagram of the relationship in the system "Process of non-autoclaved foam concrete obtaining"

For the functions y_{1opt}, y_{2opt} we take the necessary intermediate indicators of the subsystems of the technological process to obtain the final result Y^o_{opt}.

2 Method of constructing the function of the final goal of the technological process of foam concrete obtaining

To obtain the functions y_{1opt} of subsystem 1 and y_{2opt} of subsystem 2, it is necessary to formalize the functions of the influence of controlled factors on the indicators of each operation, up to the function y^o_{opt} of the entire system and to solve the multi-factor problem of determining the optimal technology for obtaining the desired building material according to the quality criteria chosen by the customer.

This means that for each subsystem it is necessary [5]:

1. To choose a specific set of k controlled factors x_k that affect the optimality criteria y_n according to customer requirements:

$$x \in [x_1, \dots, x_i]; k \in [1; i] \tag{1}$$

and to build dependencies:

$$\left.\begin{array}{l} y_n = y_n(x_1) \\ \dots \\ y_n = y_n(x_k) \end{array}\right\} \quad y_n(x_1, x_2, \dots, x_k) = y_n. \tag{2}$$

And this is provided that the factors (x_1, x_2,…, x_k) do not depend on each other.

If such a relationship exists, for example, between x_1 and x_2, then:

$$x_1 = y_0(x_2). \tag{3}$$

Then in (2) there will be not $y_n = y_n(x_1)$, but:

$$y_n = y_n[y_0(x_2)]. \tag{4}$$

As criteria of optimality y_n it is possible to distinguish intermediate quality indicators of subsystems – the components of the functions y_{1opt}, y_{2opt}, or the final indicators as a part of y^o_{opt} – the quality characteristics of foam concrete. These can be average density (ρ), compressive strength (R_b), tensile strength in bending (R_{bt}), thermal conductivity (λ), frost resistance (F), vapour permeability (μ), etc. The totality of the above characteristics makes up the vector of quality indicators of the finished product Y^o – a generalized optimality criterion by which the only acceptable solution y^o_{opt} should be chosen:

$$\overrightarrow{Y^o} = \{\rho, R_b, R_{bt}, \lambda, F, \mu\}. \tag{5}$$

2. To select a system of normalization of units of measurement of factors in order to lead to a single measurement for all (these are usually dimensionless numbers from 0 to 1) [6,7].

3. To construct functional dependencies for the control factors [8,9]:

$$y_n(x_k) = y_n\left(y_j(x_k)\right); n \in [1; q]; j \in [1; q]; n \neq j. \tag{6}$$

4. To formalize or accept the boundary conditions for the factors $a_k \geq x_k \geq b_k, k \in [1; i]$ and for the range of acceptable solutions to the customer's problem $c_n \geq y_n \geq d_n, n \in [1; q]$.

5. To assign targets – to construct objective functions with a formalization of their dependence on the selected controlled factors [10]:

$$\begin{array}{l} F_l \to max, l \in [1; q] \\ F_r \to min, r \in [1; q] \\ l \neq r \end{array} \tag{7}$$

In practice, the degree of importance of the criteria is established by agreement with the customer.

There are several variables (x_1, x_2, …, x_k) for evaluating the quality of foam concrete. They can be assigned or be given a range of valid values for each individually. Binary dependencies can be built from experiments by processing the response data by a statistical method:

$$\left.\begin{array}{l} y_1 = f_1(x_1) = f_2(x_2) = \dots = f_n(x_i) \\ \dots \\ y_n = f_n(x_1) = f_{n+1}(x_2) = \dots = f_{n+i}(x_i) \end{array}\right\} \tag{8}$$

Any criterion y_n, $n \in [1; q]$ can be taken as the objective function, and a number of its extremums can be found from the conditions of x_k: $y_n' = 0, n \neq k$. For each criterion y_n it is possible to find the zone of admissible values, knowing the values of extremums from (8).

For each y_n, it is easy to determine the most influential parameter of all x_k, $n \neq k$. Let it be x_g.

And, if this x_g is the most influential, then the rank of x_g is the highest, i.e.:

$$x_g \succ \text{the rest.} \tag{9}$$

Similarly, to continue the series (9), the second, more important of the remaining criteria, is found similarly, the third is found and so on to the last. But the customer can name and create a number of priorities. Then, for (9), the parameters to the left of the ordered one do not play a role and can become restriction conditions. The maximum or minimum of x_g is known from (8), and the values for the remaining y_n, $n \neq g$ at the extremum can be also determined from (8) and compared with the other customer requirements.

If they are in the zone of permissible values, then the problem is solved, if they do not there, then a compromise is required: a concession on x_g.

A compromise between the optimality criteria implies that the one is permissible to lose, but the other is acceptable to add.

With the compromise, the problem becomes definable and it is a mathematical model of the system:

$$\left.\begin{array}{l}\alpha_1 y_1 + \alpha_2 y_2 + \cdots + \alpha_q y_q = Y^o \\ \sum_{q=1}^{N} \alpha_q = 1; \alpha_q \geq 0.\end{array}\right\} \quad (10)$$

Y^o is a generalized optimality criterion that the units are normalized in such a way that all y_n at $n \in [1, q]$ tend simultaneously to either the maximum or the minimum. The generalized criterion can be obtained in the record as a function of any one variable using binary dependencies (8):

$$Y^o = f(x_i) = \alpha_1 y_{1q}(x_i) + \alpha_2 y_{2q}(x_i) + \cdots + \alpha_i y_{qq}(x_i). \quad (11)$$

The ratio (11) needs to be supplemented:

$$\left.\begin{array}{l}Y^o = f(x_1) = \cdots \\ Y^o = f(x_2) = \cdots \\ \ldots \\ Y^o = f(x_k) = \cdots\end{array}\right\} \quad (12)$$

For each line we are looking for *extr* $f(x_k)$, i.e. Y^o. The acceptability of the solution is checked by a real experiment, the results of which clarify the compromise between the optimality criteria, i.e. values of α_q. When Y^o is accepted as the only, albeit generalized criterion for evaluating the quality of a material, it is itself a complex function $Y^o = f(x_k)$. The compromise estimates the degree of influence of each x_k on Y^o.

In other words, although at Y^o the task is single-criterion and makes it possible to find Y^o_{opt}, it leads to a new problem: to find the domain of all y_n under the condition $Y^o_{opt} = const$. Then we define sets of values for each y_n. This set of values will determine the scope of acceptable solutions:

$$\left.\begin{array}{r}y \in \{y_n\} \\ Y^o_{opt} = const\end{array}\right\} \quad (13)$$

The correct set of y_n satisfies the equality $\sum_{q=1}^{N} \alpha_q = 1$. Thus, the calculation experiment significantly narrows the scope of the search for acceptable solutions to the customer. The importance of choosing the essence and the number of controlled factors and optimality criteria for each subsystem of the technological process becomes apparent.

3 Conclusions

Thus, the technological process of non-autoclaved foam concrete obtaining has been constructed according to the formulas (1)-(13), which we will consider as stages of the technological process. According to (13), each stage is easily programmed and its values are obtained by changing the parameters. Therefore, the technological process can also be programmed as a whole. And this will already be a program of the calculation experiment. The calculation experiment is based on the principle of determining the rates of influence of parameters on the output properties of foam concrete.

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References

[1] BUSLENKO, N.P.: *Modelling of complex systems*, Moscow, Science, 1988. (Original in Russian)

[2] VDOVIN, V.M., SURKOVA, L.E.: *System theory and system analysis*, Moscow, Dashkov and K, 2016. (Original in Russian)

[3] MALKOV, M.V., OLEYNIK. A.G., FEDOROV, A.M.: Modelling of technological processes: methods and experience, *Proceedings of the Kola Research Center of the Russian Academy of Sciences*, Vol. 3, pp. 93-101, 2010. (Original in Russian)

[4] BAZHENOV, Y.M., GARKINA, I.A., DANILOV, A.M., KOROLEV, E.V.: *System analysis in building materials scince*, Moscow, Moscow State (National Research) University of Civil Engineering, 2012. (Original in Russian)

[5] DOMNINA, K.L.: The choice of managed parameters of the process of producing of non-autoclaved foam concrete with a particular structure, *Volga Scientific Bulletin*, Vol. 3, pp. 18-21, 2010. (Original in Russian)

[6] MASHUNIN, Y.K.: *Methods and models of vector optimization*, Moscow, Science, 1986. (Original in Russian)

[7] FANG, L., CHUN-RONG, CH.: Newton-like methods for solving vector optimization problems, *Applicable Analysis*, Vol. 93, No. 8, pp. 1567-1586, 2013.
[8] FLIEGE, J., GRANA, L.M., SVAITER, B.F.: Newton's Method for Multiobjective Optimization, *SIAM Journal on Optimization*, Vol. 20, No. 2, pp. 602-626, 2009.
[9] REITMAN, M.I., SHAPIRO, G.S.: *Methods of optimal design of deformable bodies*, Moscow, Science, 1976. (Original in Russian)
[10] VOLKOVA, P.A., SHIPUNOV, A.B.: *Statistical data processing in research works*, Moscow, Ecopress, 2008. (Original in Russian)

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ENERGY RECOVERY OF BONE WASTE AS HEAT SOURCE

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Keywords: bone wastes, incineration, ash content
Abstract: Modern food industry concerning meat producers produce high amounts of bone waste. Bones represent biggest portion of zoo-mass waste which must be destroyed for hygienically reasons. Bones also have long durability and it is taken long time to decomposing this material microbiologically. We already know way to destroy this waste by crushing and making meat and bone meal. However, feeding with meat-and-bone meal can cause animal diseases. Because of that we try to prove combustion as a suitable way to get rid of this waste. Everything can be cleansed by flames and combustion also release energy captured in bone tissue. This energy can be used as heat or transformed to electric current also. But the other side, bone burning also has its emission problems that this work is trying to solve.

1 Introduction

1.1 Bone waste statistics

The bones form the supporting structure of most living creatures. The bones form a composite consisting of many small lamella particles that give them immense strength even at low weight. Average bones weight up to 18% of the total weight of the animal, it makes up the largest part of waste in zoo-mass industry. Although animal breeders try to reduce the bone-to-meat ratio by breeding it is not possible to reduce the bone mass of animals without limit. Therefore, bone waste will always make a high proportion in zoomass. About 130 billion kg of animal bone residues from pork, beef, poultry and fish is produced in global slaughter industry every year as a side stream to their core business. The biggest producers are India and Brazil, which have more than 50 % of world market.

Bone waste can be divided according to hardness into soft and hard. Softer bones are produced by small animals like fish or birds and they are easier to use. The highest proportion of bone waste forms bigger animals such as pigs and cattle (Figure 1). Their bones are harder and contains a higher ratio of inorganic component it's causes lower calorific value. Nevertheless, they make up the largest volume of bone waste without having a clear use. The weight of bovine and pork bones is about 25% of total weight of animal. One cow has 207 bones in the body that make up the weight which is about 250 kg of his weight. One pig has 216 bones and it is made up around 75 kg of his weight.

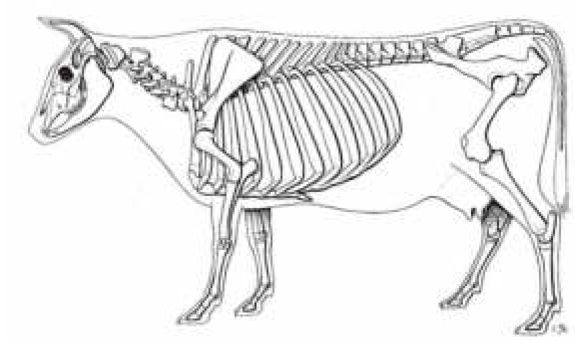

Figure 1 Cattle skeleton

1.2 Bone waste management solutions

Bone waste, on the one hand, needs to be hygienically and ecologically disposed of and, on the other hand, we can use it for energy. Energy saved in bones can only be used in two ways. Making meat-and-bone meal for feeding animals and for combustion [1,2].

1.2.1 Livestock feed

The production of meat and bone meal is verified by the long history of its production and application on the market. Feeding livestock on this energy, protein, and mineral-filled diet proved to be eastern and effective. But still some, scandals such as mad cow disease have also been shown. This disease is caused by feeding the herbivores on a fleshy diet. What's mean that not every animal should be eat this. Some meat-and-bone meal from infected animals is even banned from being used as feed, because it can also even cause disease to the rear carnivores.

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Production of meat-and-bone meal also requires milling in shredders or mills. Bone grinding is also in itself energy intensive. Exceptions are bones from poultry and fish, which on the one hand are very small and fragile but are easily digestible sources of nutrients which can be used again as a nutritional supplement for fish and poultry. Especially regarding cattle their bones are high durable and hard. Their grinding is problematic and requires expensive technologies.

1.2.2 Incineration

For these reasons we try to proof incineration as a right way to using this material. Incineration of bones is very old process used by humans for centuries too (Figure 2). The combustible part contained in the bone tissue is simply broken down when the ignition temperature is reached. In doing so, there is an energy-saving and hygienically suitable degradation of bone waste. However, in today's modern age, increased emissions and related legislation are forcing us to verify the environmental aspects of the incineration of bone waste. Because incineration also entails certain risks, mainly associated with emissions and quality of combustion process. Our article deals with the aforementioned risks and evaluates the possibility of burning bone waste in terms of emissions, ash content and heat output [3,4]. We hope that our article will show ways to burning bones ecologically and brings clean renewable energy to us.

Figure 2 Bone samples

2 Theoretical analysis

2.1 Chemical content of bone

Bone tissue is composed of two essential components that are distributed in the bone in the right ratio (Table 1). They are called organic and inorganic, and dwellings have an important impact on animal life. The inorganic portion gives the animals support and stability, and the organic again supplies the bone with energy-rich nutrients [5]. The main constituent of bone is the inorganic portion which forms a resistant solid structure crosslinked with organic fibres. The organic part acts as a catalyst and causes chemical reactions with the inorganic component, allowing it to build or decompose. Without it, bone would be like an ordinary limestone rock.

Table 1 Chemical composition of a bone

Chemical element	Ca	C	P
Percentage (%)	39.12	25.23	17.01
Mass (mg/kg)	212.25	136.89	92.29
Content (ppm)	391167	252279	170086
H	N	S	Other
3.90	3.88	0.08	10.78
39.02	38.40	0.75	58.49
39023	38404	755	107791

2.2 Bones flammability

Bone burning is a cheap and easy way to get rid of bone waste by breaking down chemical bonds in bone tissue while releasing energy. Bone tissue is composed of an organic and an inorganic component. The organic constituent is formed by elements forming exothermic combustion reactions known as C, H, N and S. However, the increased content of elements such as sulphur and nitrogen have a negative impact on emissions formation. These elements form collagen and bone lubricant in bone tissue.

Inorganic elements together with water form a ballast part of the bone. Evaporation of water consumes heat and thus reduces the calorific value of the bone fuel, but she can be removed by drying using waste heat [11][12]. The major problem with bone burning is formed by inorganic minerals, mainly represented by calcium and phosphorus, but also by elements such as Mg, Na, K, ... These elements account for up to 50% of the bone content and are transformed directly into the ash content [8,9]. Some of them even produce endothermic reactions such as calcium and thus consume heat. The temperature required to react calcium hydroxide to calcium oxide is 1000 °C, which means that even this problem can be solved with good cooling of the combustion chamber [10-12].

The inorganic part of the bones forms a bone ash, which is a valuable raw material. The production of bone ash has been known for long time, and records of the production of lime from bone ash are already mentioned in the Bible. Well-burned bones are easily broken down into dust and have versatile applications as production of ceramics, lime plastering, cement additive or fertilization because it contains a high phosphorus content [13-15].

$$Ca_3(PO_4)_2 \rightarrow CaO + P_2O_5 - 4121\ kJ.mol^{-1} \quad (1)$$
$$CaCO_3 \rightarrow CaO + CO_2 - 635\ kJ.mol^{-1} \quad (2)$$
$$C + O_2 \rightarrow CO_2 + 393\ kJ.mol^{-1} \quad (3)$$
$$N + O_2 \rightarrow NO_2 + 626\ kJ.mol^{-1} \quad (4)$$
$$S + O_2 \rightarrow SO_2 + 297\ kJ.mol^{-1} \quad (5)$$
$$\frac{1}{2}O_2 + H_2 \rightarrow H_2O + 286\ kJ.mol^{-1} \quad (6)$$

The mentioned chemical reactions (1-6) show the formation of final bone burning products with energy balance.

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3 Experimental measurements

3.1 *Determination of basic parameters*

Before performing the measurements, we determined the basic properties of bone fuel as chemical composition, moisture content, content of flammable substances and ash by means of the thermogravimetric analyser LECO TGA701.

Calorimeter LECO AC 500 was used to determine gross calorimetric value and calorific value was determined from the formula where we subtracted the heat dissipated by moisture in the fuel.

We also determined melting point of bone ashes by ash fusion determinator LECO AF700. Pyramid sample from bone ash withstood a maximum temperature of equipment which was at 1500°C. Because of it we had to search for answer in other sources. We can see stability of bone ash with comparison to other samples from phytomass ash on figure 4. All measured bone material parameters can be seen in following table (Table 2).

Table 2 Basic bone properties

Moisture (%)	4.04
Volatile flammable (%)	45.06
Fixed carbon (%)	2.46
Ash (%)	48.45
Ash melting point (°C)	1670
Gross calorimetric value (MJ/kg)	10.93
Calorimetric value (MJ/kg)	9.98

3.2 *Determination of performance and emission parameters*

Bone samples were dried using waste heat from fireplace insert (Figure 3). During the experiment, hunk samples of pig and bovine bones were burned. The weight of one loading was 7 kg. The bones were burned on grate in a modified 18kW automatic boiler. Boiler preheating was ensured by spruce wood and bones were inserted right into the hot spruce embers. Performance of the device was measured during the measurement. The following pictures document the burning process.

Figure 3 Bone samples burning

During the experiment were measured the solid particulate emission values as well as the gaseous emission values recalculated on 10% oxygen content in the flue gas. Carbon monoxide emissions accounted for the largest share which have been caused by imperfect combustion of bones due to insufficient oxygenation in the automatic boiler as well as low temperatures in the combustion chamber. Emissions of CO even decrease performance of boiler. We also noted a higher proportion of NO emissions due to N content in bones. On the other hand, the temperature rise in the combustion chamber was directly proportional to the increase in NO emissions (Figure 4). It is more likely to burn bones at lower temperatures in combustion chamber. Low sulphur emission values were probably due to the sulphur low sulphur content and especially by the reaction of sulphur with calcium content of the bones. TZL values showed an increased concentration of mainly dangerous smaller spectrum particles. But these could also be influenced by better conditions in the combustion chamber.

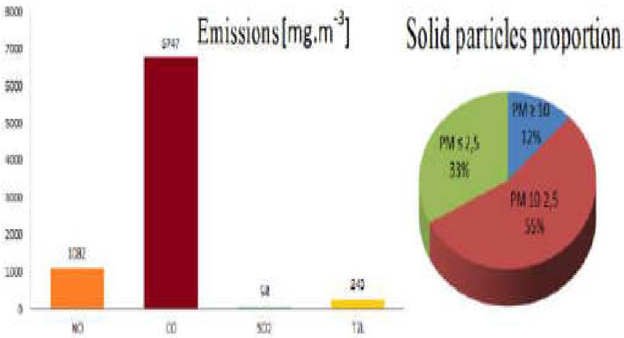

Figure 4 Average emission values during bone combustion

In the beginning, the burning was smooth and the boiler output increased to 8 kW. Subsequent loss of power was caused by the burn-out of the firing spruce wood. The bones themselves were able to maintain average power of only 2.5 kW. The temperature in the combustion chamber began to decrease, and thus the performance of the device decreased too. Although the bones continued to burn, they eventually cooled down and died out. Bones failed to burn completely, what caused increasing the heat loss by mechanical unburnt fuel parts as we can see in following picture (Figure 5).

Figure 5 Ash melting point test and imperfectly burned bones

4 Conclusion

4.1 *Results of combustion*

The results of the experiments proved that the bones are not able to burn as a separate fuel in a classic small heat source with respect to the emission limits and performance parameters of the combustion equipment. Due to their low flammable content and high ash content, they were unable to deliver the required heat output even for proper firing themselves. Subsequently we began to monitor imperfect combustion that affected emissions. However, we have also been able to monitor the positive effect of calcium content on sulphur emissions that were kept low throughout the measurement and sometimes we didn't even notice any. Bone burning itself, however, proved to be inefficient and non-ecological.

4.2 *Solutions for combustion*

There would be several solutions as choosing the right combustion plant and better fuel processing before combustion. Right combustion plant relates to the right combustion technique and adaptation the combustion plant to achieve optimal conditions in the combustion chamber as combustion temperature and air supply. This can decrease emissions and can provide better performance of equipment, however, when burning clean bones, it will still be necessary to provide flue gas cleaning by means of separators or a flue gas scrubber. For this reason, it will be necessary to focus on bone fuel processing.

Bone fuel processing seems to be the best solution for its combustion. It solves main problems which is chemical composition, the shape and size of bones what causes insufficient oxygenation and temperature maintenance in embers. First opportunity requires to break bones into smaller pieces and mixing them witch high calorimetric value fuels on classical grate boilers. Second opportunity requires to mill bone waste to bone meal and then use bone dust as additive to pellets. This solution is suitable for automatic boilers and even solve problems with low melting points of some biomass fuels because of high melting point of bone ash which increases the overall melting point of the mixture.

Bones can be used as an additive to fuels with a higher calorific value and possibly higher sulphur content, such as coal. Fuel with a higher calorific value is able to provide the temperature needed for perfect bone burning and the bones are able to incorporate the necessary emission-inhibiting minerals into the combustion process. The final bone-burning product should be a brittle easily breakable bone dust suitable for further use.

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References

[1] COSTAMAGO, S., THÉRY-PARISON, I., KUNTZ, D., BON, F., MENSAN, R.: *Taphonomic impact of prolonged combustion on bones used as fuel*, In: The taphonomy of burned organic residues and combustion features in archaeological contexts, Proceedings of the round table, Valbonne, May 27-29 2008, pp. 169-183, 2008.

[2] JANDAČKA, J., MIKULÍK, M.: *Ecological Aspects of Biomass and Fossil Fuel Combustion,* Žilina, J. Š. GEORG, pp. 116, 2008.

[3] STARON, P., KOWALSKI, Z., KRUPA-ZUCZEK, K., WZOREK, Z.: Thermal utilization of mixtures of bone waste, *Polish Journal of Chemical Technology*, Vol. 12, No. 4, pp. 26-30, 2010.

[4] ADAMOVSKÝ, F., OPATH, R.: *Heat production by biomass combustion*, Nitra, Slovak University of Agriculture in Nitra, pp. 149, 2013.

[5] POSKROBKO, S.: Identification and stabilization of combusting animal waste with active participation of bone material — Emission of SO_2 and HCl, *Fuel processing technology*, Vol. 113, No. 8, pp. 20-27, 2013.

[6] FRYDA, L., PANOPOULOS, K., VOURLIOTIS, P., PAVLIDOU, E., KAKARAS, E.: Experimental investigation of fluidised bed co-combustion of meat and bone meal with coals and olive bagasse, *Fuel*, Vol. 85, No 12-13, pp. 1685-1699, 2006.

[7] GULYURTLU, I., BOAVIDA, D., ABELHA, P., LOPES, M.H., CABRITA, I.: Co-combustion of coal and meat and bone meal, *Fuel*, Vol. 84, No. 17, pp. 2137-2148, 2005.

[8] HORÁK, J., JANKOVSKA, Z., BRANC, M., STRAKA, F., BURYAN, P., KUBESA, P.: Problems of Determination of Characteristic Temperatures of Biomass Ash Fusibility, *Chemicke Listy,* Vol. 107, No. 6, pp. 502-509, 2013.

[9] JANDAČKA, J.: *Examples of Good Practice in Biomass Heating*, Žilina, pp. 80, 2009.

[10] JANDAČKA, J., MIKULÍK, M.: *Technology for increasing energy potential of biomass*, Mojš: Jozef Bulejčík, pp. 110, 2007.

[11] TAUŠ, P., TAUŠOVÁ, M., ŠLOSÁR, D., JEŇO, M., KOŠČO, J.: Optimization of energy consumption and cost effectiveness of modular buildings by using renewable energy sources, *Acta Montanistica Slovaca*, Vol. 20, No. 3, pp. 200-208, 2015.

[12] CHUDÍKOVÁ, P., TAUŠOVÁ, M., ERDELYIOVA, K., TAUŠ, P.: Potential of dendromass in Slovak republic and its actual exploitation in thermic economy, Potenciál dendromasy SR a jeho aktuálne využitie v tepelnom hospodárstve, *Acta Montanistica Slovaca,* Vol. 15, No. special issue 2, pp. 139-145, 2010. (Original in Slovak)

[13] VALANČIENE, V.: Utilization of Meat and Bone Meal Bottom Ash in Ceramics, *Materials Science*, Vol. 17, No. 1., pp. 86-92, 2011.

[14] DEYDIER, E., GUILET, R., SARDA, S., SHARROCK, P.: Physical and chemical characterisation of crude meat and bone meal combustion residue: "waste or raw material?", *Journal of Hazardous Materials*, Vol. 121, No. 1-3, pp. 141-148, 2005.

[15] SKODRAS, G., GRAMMELIS, P., BASINAS, P.: Pyrolysis and combustion behaviour of coal–MBM blends, *Bioresource Technology*, Vol 98, No 1., pp. 1-8, 2007.

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DESIGNING AN AUTONOMOUS SYSTEM FOR THE PURPOSE OF RECEIPT AND DISPATCH OF MATERIALS BASED ON MOBILE APPLICATION

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Keywords: Information systems, programming, RFID, logistics
Abstract: The article deals with the design of an autonomous system for the purposes of receiving and dispensing material based on a mobile application. The article contains analysis of automatic identification technologies, methods of electronic data exchange and description of the system itself. The automatic identification systems (SAI) have great importance in increasing company's responsiveness, quality increase and cost reduction. These systems could be used within various areas of human activities from food processing industry through heavy industry to wholesale.

1 Introduction

The importance in managing all flows in the business is growing. Development of new technologies such as smart homes and industrial facilities, using drones for various activities, or Internet of Things (collectively named Industry 4.0) bring new methods of their management. With an expanding amount of goods, the data processing needs to be quicker and more effective. The use of technologies mentioned above is an excellent way of doing so.

2 Methodology

2.1 Technologies used in automated identification systems

The automatic identification systems (SAI) have great importance in increasing company's responsiveness, quality increase and cost reduction. These systems could be used within various areas of human activities from food processing industry through heavy industry to wholesale. Using them is required because of needs of improvement of logistics information systems. Automatic identification systems are systems meant to create, collect, and accelerate information processing and improve accuracy. These systems are being developed along with information technologies. Using SAI allows to process more information, it saves time by eliminating manual data processing and it minimizes impact of human factor as well [1].

Basic concept of these systems is creation and collecting information to ensure accurate data and automate related activities. Accordingly, it is possible to determine their key advantages: Increasing efficiency i.e. workers are able to do more work in the same time. Due to the automation of identification, the amount of administrative activity is considerably smaller, as the systems performs it. Since it is automatic system, it performs all task according to exact, predetermined procedures defined by developer without significant user intervention. Therefore, proportion of errors caused by human faults is minimal, as is the cost of sorting information manually. Another significant advantage is the improvement of customer services in the form of providing required information without delays.

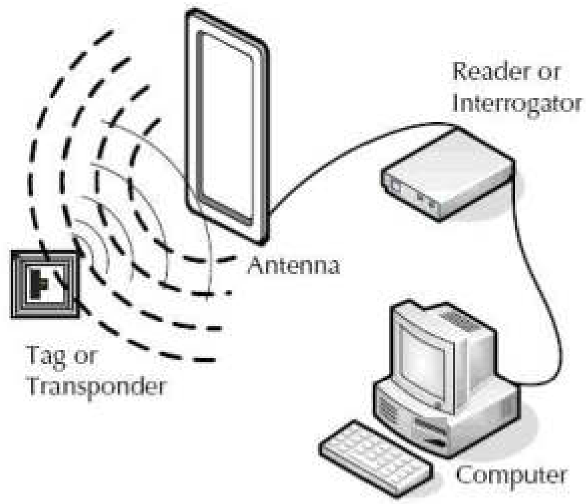

Figure 1 s RFID schema [2]

There are various technologies to process data. The most common technology are barcodes however, RFID technology is getting in the lead eliminating barcode imperfections and flaws such as sensitivity to printing quality, weather conditions, handling (Figure 1). Unlike barcodes, RFID chips do not require immediate proximity of chip and reader, and the date are read even if the reader is several meters away, and these two objects don't see each other [3].

2.2 Electronic data interchange

The use of electronic communication minimizes the need for manual information processing and allows the sending of structured messages from the sender's computer to the recipient's computer. In order to use this method of communication, it is necessary to provide hardware equipment (computer connected to the network), software, and operator communication services [1].

EDI-based data exchange uses structured files. These files have different formats and not every format is suitable for use in any conditions. The most common formats are:

.XML - The structure of such files is readable for both computers and humans. it is very similar to HTML, but HTML is used to display data (used when writing web pages) (Figure 2). The advantage of XML is its ability to simplify sharing, transfer availability and compatibility between different platforms because it stores data as text without formatting [3].

.JSON - a language for storing and transferring data in a structured form based on JavaScript programming language. It can be used in various other programming languages.

.CSV - data are separated by comma, or a predefined character. Similar to previous types, .CSV stores data as plain text without formatting, but compared to .XML or .JSON, .CSV files have a much simpler structure [4].

Electronic data exchange brings several advantages over the classical form. First and foremost, when you exchange data electronically, time and work are saved because specific information is not needed to be entered multiple times. Data exchange takes place almost immediately after it is sent, so the time it takes to physically move documents can be used in a different way. The fact that there is no need to rewrite the data several times reduces the possibility of a false entry. In addition, the possibility of an error caused by a carrier in the form of loss or destruction of a document is also minimized. Electronic data exchange also increases flexibility in responding to customer requests.

```
<?xml version="1.0"?>
- <job>
  - <production>
      <ApprovalType>WebCenter</ApprovalType>
      <Substrate>carton 150 gr</Substrate>
      <SheetSize>220-140</SheetSize>
      <press>SuperFlat2</press>
      <finishing>standard</finishing>
      <urgency>normal</urgency>
    </production>
  - <customer>
      <name>FruitCo</name>
      <number>2712</number>
      <currency>USD</currency>
    </customer>
</job>
```

Figure 2 .XML file structure [5]

2.3 Project of system for receiving and dispatching materials

The system is designed in MS Excel 2013. While the system works in newer versions of Excel, backward compatibility is not guaranteed as older versions may not support the features that were used to create this system.

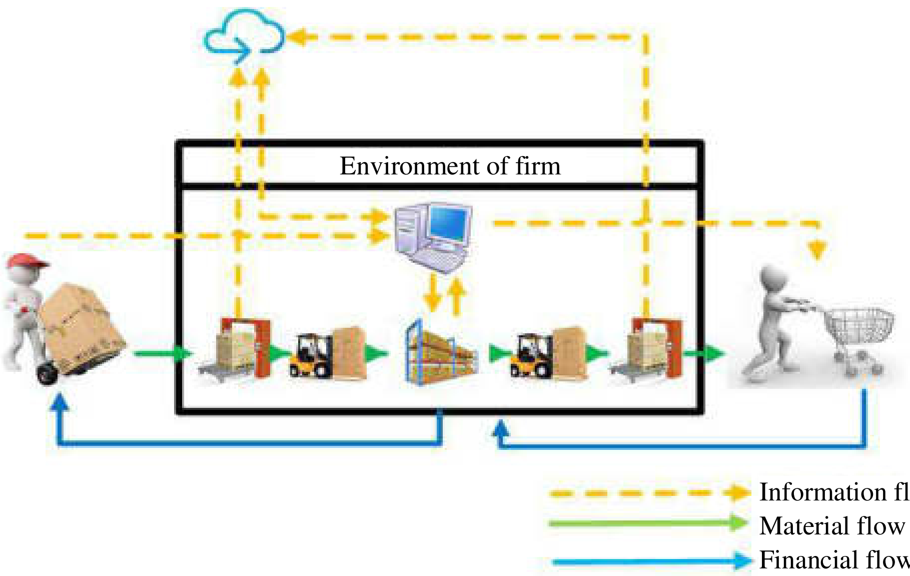

Figure 3 schema of the system

The system (Figure 3, Figure 4) works with external data that can be stored on the local hard drive of a computer, server organization, or cloud server . In practice, the most used method of storing on a particular organization's server, because storing on the hard drive of the user's computer is impractical and the use of cloud services is costly, and reliability and security is not guaranteed. The proposed system works with data stored on the computer's hard drive. These data are automatically loaded into the appropriate databases when opened. In addition, the data can be updated as needed. When work with the system is completed, the external data is updated depending on the changes. The cloud is used only as the data carrier from the NFC card simulating a particular material palette to the computer when it is received or dispatched.

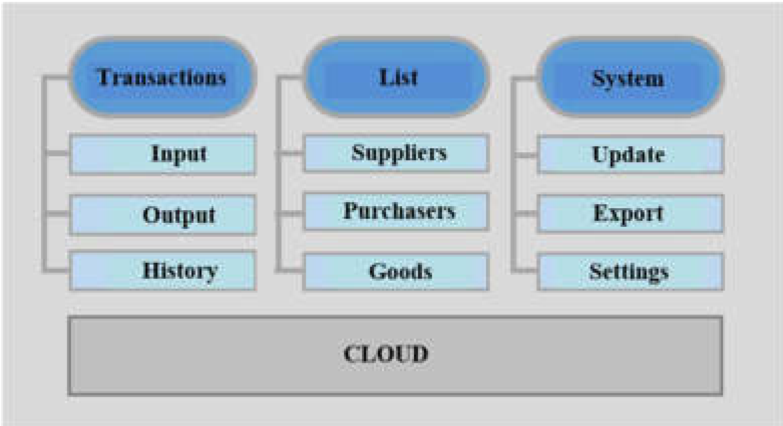

Figure 4 Main menu of the system

The system designed in this work uses NFC technology. There are many manufacturers and NFC reader types are within the market, but most require a USB cable to connect to a computer, which may be restrictive. This problem can be eliminated by a reader that can transmit data over a wireless network, whether using Bluetooth or WiFi.

Figure 5 shows the operation of the system. The first step is to pair the order with the delivery note. Subsequently, supplier data is added and the system starts loading NFC tag information and records it in the appropriate databases and updates the inventory status. In addition, it also archives all transactions and can generate the necessary documents.

3 Conclusion

The aim of the work was to design an autonomous information system in MS Excel environment using RFID technology, evaluate the efficiency and economic benefits of the proposed system.

The work includes a description of the system and its functioning to maintain its functionality. It uses NFC technology, which is significantly cheaper than RFID technology. However, it has some limitations that can be eliminated by further research.

Complete automation is possible to automate the individual processes to a great extent and, compared to the system proposed in previous work, the benefits of time saving, error minimization and barcode quality dependency are significant.

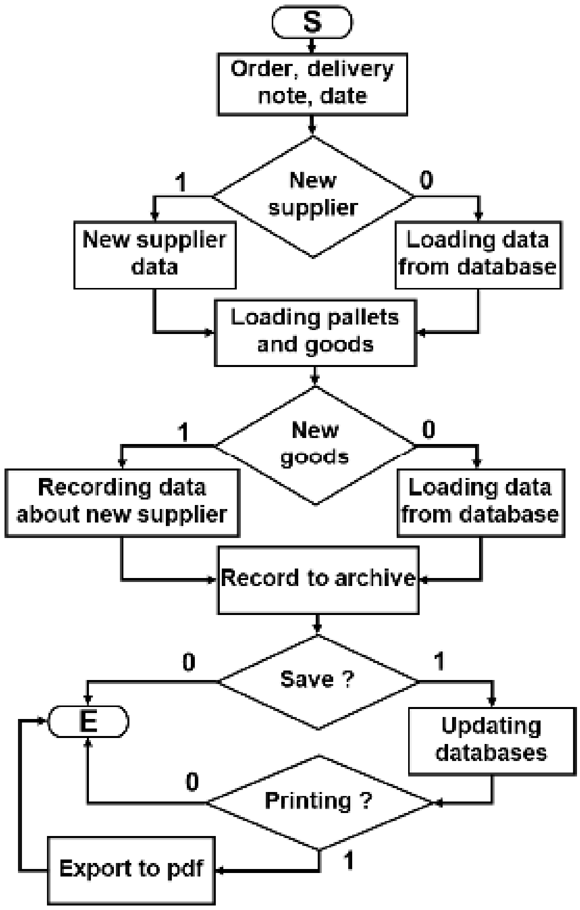

Figure 5 system algorithm

References

[1] BALOG, M., STRAKA, M.: Logistic Information Systems, Logistické informačné systémy, EPOS, pp. 208, 2005. (Original in Slovak)
[2] What is RFID?, [Online], Available: https://www.epc-rfid.info/rfid [4.12.2018], 2018.
[3] ŠKAPA, R., KLAPALOVÁ, A.: Řízení zpětných toků, Management of reverse flows, Brno, Masarykova univerzita, 2011. (Original in Czech)
[4] What Is a CSV File, and How Do I Open It?, [Online], Available: https://www.howtogeek.com/348960/what-is-a-csv-file-and-how-do-i-open-it/ [3.12.2018], 2018.
[5] Introduction to XML, [Online], Available: https://www.w3schools.com/xml/xml_whatis.asp [3.12.2018], 2015.

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