METHODOLOGY OF LOGISTICS PROCESS ANALYSIS IN METALLURGICAL ENTERPRISES

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Abstract

The logistics processes in metallurgical enterprises can be characterized by the high complexity resulting from long production cycles, wide product portfolio, decreasing volume of individual orders and considerable product dimensions. During the historical development of most metallurgical enterprises, a continuous system of logistics processes improvement was not implemented, thanks to which they would be optimized due to the changing conditions of the industry. The aim of the article is to propose the methodology of logistics analysis in metallurgical enterprises that will systematically analyze and evaluate logistical processes, identify, classify and prioritize key issues, and efficiently design the process of their solutions.

Keywords: Metallurgical enterprises, logistics process analysis, methodology

1. INTRODUCTION

In the context of metallurgical industry specifics Malindzak [1] presents some characteristics of metallurgical enterprises and its' portfolios', which are for example long production cycle and big amount of material flows as well as high investments and long life-cycles, resulting in long recoupment period and long periods between improvements. Thanks to this fact, the logistics processes analysis in metallurgical enterprises is more complicated than in other industrial branches and requires a creation of a specific methodology. The need of this methodology results also from the findings performed by comparison and realization of logistics projects in several metallurgical enterprises and discussions with stakeholders who confirm previous sidelining of the logistics processes compared to the manufacturing and commercial processes in the course of dynamic development of this industrial branch. Lakshmanan [2] also writes about a need of permanent improvement of the processes in the metallurgical industry. He considers innovation of processes to be a basic activity which enables the enterprises to build their market position. Ślusarczyk and Kot [3] also emphasize that efficiently accomplished processes of transport and logistics are one of the most important growth factors of competitiveness. Nowicka-Skowron and Ulewicz [4] refer to necessity of integration of the logistics into the quality management process, because only the interaction of these elements will allow the organization to function effectively in the market and attract new customers. Also Zimon [5] in the study on developing guidelines for quality in supply chain of metallurgical enterprise acknowledges that there is no doubt that a properly organized and managed logistics subsystems backed up with quality management concepts and technology have a significant influence on the process of production and distribution of products.

The general process analysis, which is performed as a step-by-step breakdown of the phases of a process, used to convey the inputs, outputs, and operations that take place during each phase. is considered to be a base in the design of a methodology of the logistics processes analysis. A process analysis can be used to improve understanding of how the process operates, and to determine potential targets for process improvement through removing waste and increasing efficiency. Davenport [6] has already stated that to understand and analyze a business process helps to recognize the sources of problems and ensure that they are not repeated in the new process, thus providing a measure of value for the proposed changes, which very well applies for logistic processes. Vergidis et al [7] present the different types of business process analysis and presents a variety of representative approaches found in literature, which formed a background for further development of current methods. At the present time, there is a lot of available methods and tools for the analysis of processes, which are being used across the industrial branches. As a suitable method for the logistics processes analysis, Tvrdoň et al [8] considers to be, for example, a logistics audit method, which is standardized, evaluation and project process focused on logistics functions. As Rogala [9] specifies, internal audit is a tool to diagnose the functioning of the organization in an independent, objective and systematic way. The result of the logistics audit is the evaluation of all the logistics functions linked to the strictly structured and very exact list of the deficiencies in logistics. The list is followed by the set of proposals and recommendations how to improve the logistic processes in the company [8].

There is, however, a series of other methods and approaches applied for the enterprise processes analysis. In most cases, these are specific methods which is suitable to combine among each other in a complex conception of the analysis. For example, Root Cause Analysis belongs among the most frequently used ones. Wieczerniak at al [10] compares and evaluates its partial tools in his study on the basis of practical experience from enterprises. Another methods of process analysis are modeling and simulation [11], Mistake-proofing, Gap analysis or Value-Added Analysis. The analysis and consequential improvement of processes is usually initiated by mapping of a current state of the processes, respectively by creation of a model of the investigated process.

The aim of the article is to propose the methodology of logistics analysis in metallurgical enterprises that will allow to systematically analyze and evaluate logistical processes, identify, classify and prioritize key issues, and efficiently design the process of their solutions. The methodology will provide a support to the processes of continuous improvements in metallurgical enterprise, which has its very specifics resulting in high complexity of logistics processes. The proposed methodology applies general principles of the process analysis supplemented by processes evaluation, identification of weaknesses and proposals of solutions including prioritization of solution of separate problems, whereas this methodology proposes to be a transparent and understandable conception applied for the support of managerial decision-making in improvement of the logistics processes of the metallurgical enterprises.

2. DESIGNED METHODOLOGY

The proposed methodology is not a linear process. Especially in case of using in big metallurgical enterprises with complicated material and information flows, it has iterative character with frequent feedbacks. While implementing the logistics processes analysis, which has to be in accordance with particular conditions in the enterprise and its surrounding, it is necessary to bear in mind the following characteristics:

- implementation of the logistics processes analysis is an original and creative approach, which doesn't exclude the use of partial formal methods and approaches which simplify the mindset.
- partial activities specified in the methodology are often mutually linked and overlapped from the point of view of time, resources and information,
- the logistics processes analysis is an iterative (gradual) process with backward returns to the earlier performed and repeatedly evaluated activities,
- the logistics processes analysis has to be carried out repeatedly because in this case it could react to the enterprise's changes and changes in the enterprise's surroundings which are highly dynamical at the present time.

The methodology for the creation of the logistics processes analysis consists of the following steps (see **Figure 1**):

1) Aim Specification - the general aim of the logistics management is provision of enterprise's competitiveness This aim can be further split into two basic parts. Outer aims, which are focused on satisfaction of the customers' requirements in a form of logistics services, and inner aims, which are focused on minimizing the logistics costs. A purposeful logistics processes analysis should support one or two of these partial aims. In the practical application, the aim should be defined as narrowly tailored

as possible. This task can be significantly complicated at the beginning; and definition of the aims with the use of the SMART method is often solved until after the initiation of steps 2-7.

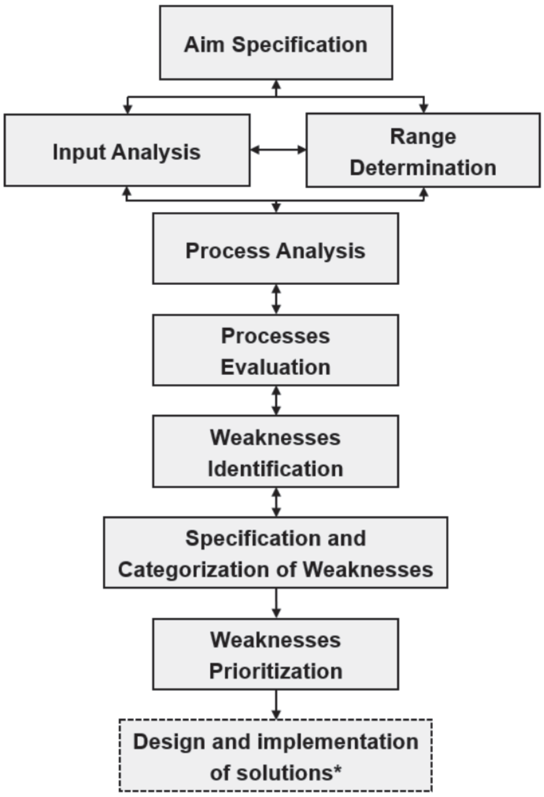

Figure 1 Methodology of logistics process analysis

2) Range Determination - after the aim is determined, it is also necessary to determine a range of the analyzed processes, especially to specify borders, within which this analysis will go on. The borders have to be determined for all partial areas of investigation, it means separate types of logistics flows, such as a material flow and information flow. Within determination of the range, it is also suitable to specify basic presumptions which will be considered in the next steps of the analysis. Both limitations and presumptions can be also developed on the basis of information obtained in the next steps of the analysis (3-7). Especially the input analysis is the basic source of this information, that's why steps 2 and 3 are being performed, as a rule, simultaneously.

3) Input Analysis - this step serves mainly for understanding and analyzing wider relations. Together with the analyzed logistics processes, it investigates their direct surroundings as well. Especially previous and consequential processes and their parameters influencing the investigated area. A typical example in metallurgical enterprises is the analysis production factors (production resources, production subjects, production technology and organization of production). The collection of necessary information is performed by means of interviews with the interested employees, as well as analysis of the available documentation and on the basis of direct monitoring of the course of production.

4) Process Analysis - the process analysis itself is focused on the mapping of the course of the work. It defines separate activities performed within the given process and their mutual relations. It assigns inputs, outputs and eventually sources (executive and responsible persons, technology, methods, time) to particular activities. A suitable tool for catching the results of the process analysis is a combination of flow charts and structural text. Within unification of outputs, authors recommend using of Business Process Model Notation (BPMN) [12] for the creation of flow charts. This method is a worldwide standard in these problems. It is also suitable to work out partial analysis for certain activities, for example, in a

form of layout analysis, statistical monitoring of the course, analysis of equipment and employee usage, analysis of documentation and IT systems. A wide spectrum of available analytic methods and tools can be used for these partial analyses.

5) Processes Evaluation - basic evaluation should be performed at the level of separate processes, whereas their overall maturity, effectiveness and sustainability should be evaluated. Principles of process classification according to Capability Maturity Model (CMM) [13] can be used for this purpose. This model divides processes to 6 categories depending on their maturity. Since process maturity is significantly general idea, it is necessary to more closely define selected process parameters which are to be evaluated. Formalization, measurement, assessment, planning and improvement can belong among the considered parameters of process evaluation.

6) Weaknesses Identification - after general evaluation of the processes, identification of weaknesses is performed for the selected processes. The identification serves for finding selected activities or other partial areas, which negatively influence functionality of the process as a whole, especially with regards to the specified aim of the logistics processes analysis. The outputs from the earlier performed analyses and other tools, for example, Ishikawa diagram, SWOT Analysis, Root Cause Analysis, Brainstorming can be mainly used for the purpose of identification.

7) Specification and Categorization of Weaknesses - together with the basic characterization, the identified weaknesses have to be specified and categorized more in detail. The authors of the paper recommend realization of this step by means of a table which will clearly display the investigated properties and parameters of particular weaknesses. The basic recommended structure is shown in **Table 1**. The designation of the weakness should be clearly and simply trackable, that's why the authors recommend numeral structural marking related to the name of the process in which the weakness is situated. The next section of the table includes classification of problems from the point of view of the following areas: process (P), information and communication (I), technical and technological (T), organizational and control (O) and human resources (H). The classification is carried out by extern evaluation of the dominant factor, although the problem area can also interfere in another category.

Table 1 Specification and categorization of weaknesses

Marking		Category	Problem description	Problem cause	Problem consequence	Target state	Approach to the solution
Number	Process	P, I, T, O, H					

Another part of the table includes short text characteristics gradually describing the given problem, its causes, consequences, the required target state and possible approaches for the solution.

8) Weaknesses Prioritization - to determine priorities, the authors recommend evaluating the identified problem areas by means of subjective point scales. The following criteria can be, for example, used for evaluation: demandingness of the solution, expected impact of the solution and costs of investment, respectively costs of problem solving (see **Table 2**). The evaluation can be performed in several phases. For example, on the basis of a model when the evaluation in the first phase is performed individually by separate members of the team of resolvers, and separate outputs within a workshop are discussed and unified within the second phase. To decrease subjectivity, it is suitable to define separate levels of the point scale with text descriptions.

The result of evaluation of the identified problem areas should be represented graphically. The basic purpose of the given prioritization is to determine an affective procedure in improvement of the investigated processes, respectively when designing and implementing separate solutions. This step is already not a part of the logistics processes analysis itself, however it is its natural continuation.

Table 2 Subjective point scale for the evaluation of demandingness, consequences and costs to the solution of the identified problems

Subjective point scale					
Demandingness		Costs		Expected consequence	
1	Easy	1	Low	1	Big
2	Middle	2	Middle	2	Middle
3	Complicated	3	High	3	Small

3. CASE STUDY

The methodology was verified on the example of the logistics processes analysis in the rolling-plant dispatch storehouse of the selected metallurgical enterprise. The aim of the simplified description in this chapter is to show the basic principles of the realized case study which was solved by the authors team in 2017.

The aim of the analysis was to find out a solution which would effectively decrease the total time of the dispatch of the finished products by vehicles from the rolling-plant dispatch storehouse. At present, this time exceeds the required limit and negatively influences the economics of the whole process.

The interrelationship of manufacturing and dispatching processes was investigated within the input analysis. Especially logistic parameters of the processes of cooling, straightening, cutting and collecting. The basic parameters of dispatching processes, including their space configuration, were also analyzed. Layouts of separate dispatch halls and storage places were created for these purposes.

A range and presumptions for the creation of the analysis were defined at the same time. They were discussed and confirmed by responsible persons. The subject of the analysis was mainly clearly defined, the investigation area was limited and the included ICT infrastructure was characterized in the given step. The limitation of the investigated area was performed for two basic planes of the analysis. In the information plane, the event of "the acceptation of a customer’s order" was chosen as a start, and "the handing-over of documents necessary for picking-up the products" was selected as the end. In the plane of the material flow, the start was set on the event of "entering the bunches to the dispatch storehouse", and the end to the event of "the drive-away of the loaded vehicle with products from the metallurgical enterprise territory". Partial presumptions defining basic parameters of the investigated processes were defined as well.

4 basic dispatch processes were investigated and documented within the process analysis itself. These processes are as follows:

- The process of planning and organization of the finished production dispatching by vehicles.
- The process of creation and placing of bunches of the finished products.
- The process of dispatching by vehicles.
- The process of loading of the products onto the semi-trailer.

Descriptions consisting of a structural text, flow charts created according to the BPMN notation and other analyses were created for separate processes. Analyses of the use of the manipulation equipment (cranes) and human resources (dispatch foreman, planning engineer, foreman of loading, binders, crane operators) were mainly performed for the selected processes. An analysis of stored portfolio of the finished products were also performed within the process of creation and storage of the bunches of the finished products. Within the dispatch process by vehicles, the statistical analysis defines time distribution of the delivered vehicles within a work day and week; beside of that, the statistical analysis defines the time they spent in the territory of the metallurgical enterprise.

Separate processes were consequently evaluated, whereas they achieved fourth (Defined) respectively fifth (Managed) level according to the CMM Categorization. The processes generally lacked a quantitative measurement of performance. Although there are internal materials and rules for the processes management, it could not be said that they were thoroughly implemented, observed and continually improved. The processes can be characterized by a low support with information and communication technologies. The present situation of the processes can be described as long-term unsustainable in conditions of dynamical development of the environment, the growing range of the assortment and increasing complexity of orders. A significant share of the kept records of running processes is implemented manually, in a paper form or by means of manual updating of electronic and afterwards printed records. This method of keeping records on realized processes is time-ineffective, can cause human factor errors and also potentially enables intentional recording of false data. The processes, for which in principle exist standard procedures, are not protected by an effective system for the support of decision-making in important decisive nodes. The decision, thus, is exclusively a matter for a responsible employee, and it is impossible to ensure a similar decision in case of repeated occurrence of similar conditions. This fact places high demands on employees in the spheres which could be effectively resolved by means of information technologies; also, probability of failure of the process is increased as a result of human mistakes or simple absence of an experienced employee or due to inexperience of a new employee.

11 problems were defined within identification of weaknesses: Their identification grew mainly from the previous analyses, partial evaluation of separate activities and structural interviews with employees of the dispatch storehouse. These 11 problems were presented to the management, and structured description and categorization were consequently created on the basis of the pattern specified in **Table 1**.

Particular problems were consequently evaluated from the point of view of effectiveness of their solutions. The effectiveness of the solutions was represented by three parameters: demandingness, cost rate and impact. A 3-point scale, which decreased subjectivity of evaluation, was defined for each criterion. For example, the Level 1 (simple) was defined for demandingness as follows:

- it doesn't require a wide range of employees or extern partners,
- it can be submitted to an employee or a team of employees for the internal solution in a form of a task (or to a supplier),
- it can be managed in relatively short time (days - months) depending on a character of the problem,
- it doesn't require specific professionalism above the frame of knowledge and experience of the employees who realize the touched process.

Based on assignment of the levels in particular categories, selected problems can be prioritized. A diagram showed in **Figure 2** was compiled for this purpose.

A growing cost rate and demandingness of problem solving are shown on axes *x* and *y*, and separate problems are represented by circular patterns, whereas their size and color define a measure of positive impacts on shortening the dispatch time. After discussion with the management of the dispatch storehouse, it was decided to solve the problems 5 and 6 which shows the best proportion between cost rate, demandingness, and measure of positive impacts.

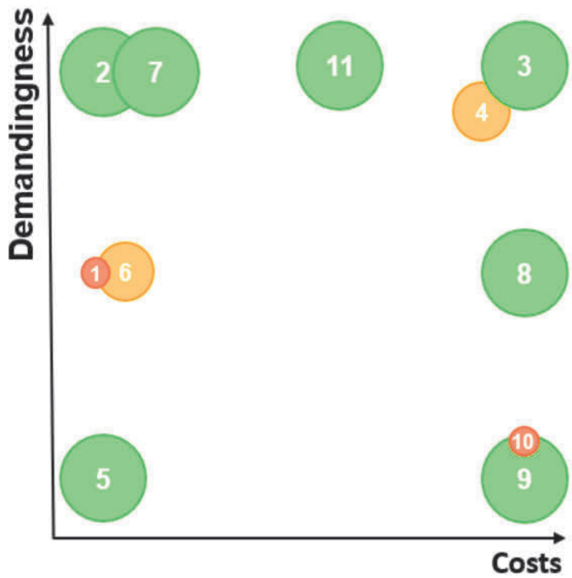

Figure 2 Graphical expression of the results of prioritization

4. CONCLUSION

The paper proposed methodology which is primarily destined for the analysis of complicated metallurgical logistics processes. This methodology is based on a process analysis and includes the following steps: aim specification, limitation of a range, input analysis, processes evaluation, weaknesses identification, specification and categorization of weaknesses and prioritization of weaknesses. A natural consequential procedure is, then, proposal and implementation of a solution eliminating selected weaknesses of the resolved area. Viability of the proposed methodology was verified by a case study in the rolling plant environment, where optimization of the dispatch processes was solved. The main aim of the solved case study was to shorten the dispatch time, which would bring both to the improvement of the logistics services and to the grow of the cost effectiveness of the dispatch process.

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