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Optimization of Logistics Costs in Dispatch Processes of Metallurgical Enterprises

Optimalizace logistických nákladů v expedičních procesech hutních společností

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This article discusses the optimization of logistics costs in dispatchprocesses of the metallurgical company. The aim of the paper is to present a general methodology of mapping, improving and optimization of logistics processes and subsequently to show the possible use of this methodology in practice on an illustrative case study. The first part of the article presents a general methodology consisting of mapping the current state of the process, identifying deficiencies in the process and their causes, and proposing measures to eliminate these problems and their causes. The methodology uses process modeling tools and quality management tools. The case study in the second part of the article shows a general example of the use of the methodology, described in the first part of the article, in optimizing the dispatch processes of rolling mills.

***Key words**: optimization; dispatch; logistics; process mapping; wasting*

Článek pojednává o optimalizaci logistických nákladů v expedičních procesech hutních společností. Cílem článku je představit obecnou metodiku mapování, zlepšování a optimalizování logistických procesů a následně na ilustrativní případové studii ukázat možné využití této metodiky v praxi. Nejprve je popsána obecná metodika skládající se z mapování současného stavu procesu, identifikace nedostatků v procesu a jejich příčin a z návrhu opatření k eliminaci těchto problémů a jejich příčin. Jsou přiblíženy nástroje modelování procesů a managementu kvality. Případová studie ukazuje obecný příklad využití uvedené metodiky při optimalizaci expedičních procesů válcoven. V první části případové studie je uveden postup sběru vstupních informací a následné tvorby procesní mapy na základě sběru informací z procesu. U této části se nachází příklad procesní mapy ve formě procesního diagramu. V druhé části případové studie je uveden postup pro identifikaci nedostatků procesu a jejich příčin a následná prioritizace problémů a postup při hledání kořenových příčin nejzávažnějších nedostatků. V této části je přiblížen postup pro využití nástrojů managementu kvality při analýze nedostatků procesu. Příkladem využití nástrojů managementu kvality je aplikování Ishikawova diagramu pro rozklad problému na jednotlivé příčiny. V závěru článku jsou shrnuty výstupy ze zlepšovacího projektu, které jsou prezentovány formou tabulky obsahující matici kategorizace nedostatků dle priorit.

***Klíčová slova**: expertní systémy optimalizace; expedice; logistika; mapování procesů; plýtvání*

In the field of industrial systems management of logistics is currently the most commonly used term. Logistics is currently given such importance for maintaining the company competitiveness, globalization of the market, growing complexity of individual customer requirements, and above all reduction of logistics costs, because logistics is now linked to production efficiency as never before and the logistics costs of a manufacturing enterprises can account for up to 70% of total costs. To achieve these goals, it is essential for an enterprise to understand and manage all logistics-related activities as processes [1].

The management of logistics processes is intended to satisfy customer requirements while spending a minimal amount of resources. Experts in the field of logistics are currently engaged primarily in optimizing logistics costs. There are different approaches to reducing logistics costs. One possible approach is to implement new concepts of logistics systems, such as just-in-time, leanness, or one-piece flow. Implementing these concepts is a lengthy and complicated process requiring considerable investment.

It is often the case that the company wants to optimize its logistics costs, but it does not have enough resources to implement the logistics concepts outlined above. In such cases, alternative approaches to optimizing logistics processes and costs need to be sought. One of the alternative approaches is the introduction of gradual continuous improvement through small steps in the spirit of Kaizen philosophy [2, 3].

Enhancement of logistics processes always begins by observing, measuring, analyzing, and mapping the current state of processes. Process mapping serves to identify and standardize the whole process but, above all, to identify problem areas within the process that leads to waste. Waste is a concept that identifies activities that consume resources and capacities, but do not add value. Waste is

divided into three basic types of Muda (overproduction, surplus), Mura (insufficient process integration) and Muri (overloading workers and equipment). It is important to identify all the shortcomings and their causes because each shortage of process that causes waste has more than one cause and it is, therefore, necessary to map all the contexts in the process thoroughly. Eliminating identified causes of waste is the goal of corporate improvement activities. The aim of this article is to present a methodology for mapping processes, identifying deficiencies and subsequently improving processes [1, 4].

1. Methodology for mapping, improving and optimizing the dispatch processes of metallurgical enterprises

Process improvement is a continuous process of analyzing waste and its causes and then designing and implementing measures to eliminate waste and increase business process efficiency. Tools for streamlining logistics processes are optimization and management of logistics chain, collaboration with suppliers, kaizen approach, standardization of logistics processes, process automation, information systems, etc. All these tools are used to identify and eliminate the causes of waste within logistics processes [4, 5].

Companies often resort to non-investment-enhancing activities. These activities include kaizen approach, which consists of continuous gradual improvement by small steps. These minor improvements should be initiated by all company employees at all levels. Employees know the business processes best and are therefore more than adequately qualified to suggest possible improvements [3, 6].

Methodology for process mapping

The optimization and improvement of business processes are preceded by their analysis and mapping. An analysis of the current state of processes is used to get acquainted with the process and to understand it, which is necessary for further activities [3, 5].

First, the process is observed, measured, all available historical data is collected, and other additional information is gathered through questioning and discussion with staff. Based on the obtained data and information, a text description of all the partial activities in the process is drawn up. Subsequently, this text description of the process is used as input for compiling a schematic graphical representation of the process and all the partial activities in the process, including their mutual sequence, continuity, and context [6, 7].

A number of processes and tools exist for process mapping, each having its own specifics. Before you begin mapping the process, you need to identify the purpose, for which the process is mapped and what outcome is expected from the mapping. Depending on the purpose of the mapping, the appropriate procedure is chosen [7].

A process chart is best suited for graphical representation of industrial processes. The process diagram is basically a flowchart, but for the mapping of industrial processes, there is a number of different sets of rules, principles, graphic symbols, and so on, by which a standard methodology for developing flowcharts has been extended. In addition to sub-activities and their sequence, the process diagram, in addition to the flowchart, includes a number of additional information at each stage of the process, such as activity outputs and inputs (data, documents, reports, material, products), responsible and collaborating persons, related sub-processes, IT systems and databases, and much more [2, 6].

An example of a set of rules and principles for creating process diagrams of business processes is the notation or graphical language of BMNP – business process model and notation, which is actually a standard for creating process diagrams. BPMN is a unified method of plotting business processes. It consists of predefined graphic symbols that have a clearly defined appearance and meaning and therefore cannot be confused or misunderstood. The great advantage of this notation is its brevity, simplicity, clarity, and logic, which makes the diagrams created according to this notation easy to read for all who have some experience with process diagrams. Significant benefits are unified graphic symbols and a uniquely defined system of process drawing. Thanks to this, the diagrams thus created are easy to read for employees at all corporate levels, all centers, and all experts, which greatly facilitates the communication and collaboration of individual staff and business centers [5, 7].

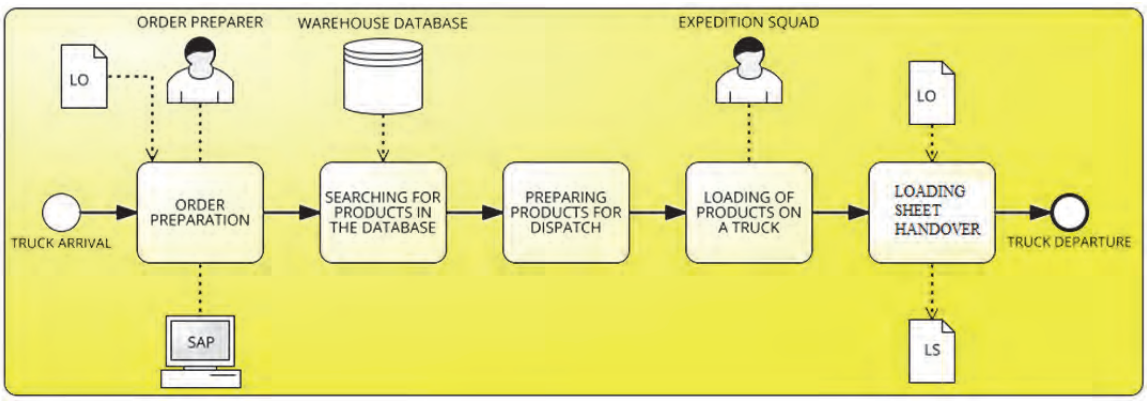

Fig. 1 Example of process diagram: Process of loading products on a truck. Source: our own data
Obr. 1 Příklad procesního diagramu: Proces nakládky výrobků na kamion. Zdroj: vlastní

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Fig. 1 is an example of a flowchart created according to the BPMN notation. The picture shows a simple process of loading goods on a truck that begins with the arrival of the truck and ends with the departure of the laden truck

Methodology for identifying causes of waste and proposing measures to eliminate them

After the entire studied process is thoroughly mapped and understood, it is possible to identify the process deficiencies and their causes. This stage concentrates on discovery of activities and segments in the process with inefficient use of resources, capacities, workers and time. Typical examples of inefficient logistical processes are manifested by redundant material manipulation, excessive staff movement, waiting, inadequate integration of processes, insufficient information flows, and overloading equipment and workers. It is in the interest of every company to limit these inefficient activities to the necessary minimum. An important indicator for logistics processes is the process realization time, which is the time from the receipt of the order to the receipt of payment, or the time from the start of storage of the product to its dispatch [8, 9].

For logistical processes, the duration of all partial activities is one of the most important data for each activity, due to the fact that delays and waiting are the cause of a whole series of unnecessary costs, whether in the form of fines from customers for delays, losses resulting from unused capacities of devices or losses resulting from unused working time of workers [5, 9].

When identifying the causes of waste in logistic processes, it can be said that the causes of delay and waiting are identified. Segments in the process with inefficient use of resources, which cause delays and waiting, are identified by measuring the duration of each activity and by analysis of measured data. The data analysis focuses on the average duration of individual activities and on deviations from this average time. The measured data that deviate from the average time are further investigated and the cause of their deviation from the average is sought. Activities with the greatest occurrence of deviations are probably inefficiently implemented or managed and should be optimized. Conversely, activities that deviate minimally from the average are well-managed both in the process and managerial terms, and there is no point in dealing with their optimization until the problematic areas of the process are resolved [6, 7].

For identification of the causes of waste the quality management tools are used, such as histogram, Pareto diagram, control diagram, Ishikawa diagram, and flowchart. Histograms and control charts are used to analyze the duration of each activity and they are greatly suited for revealing deviations and remote values. The Ishikawa diagram serves to decompose the problem to its individual causes and to identify the root cause of the problem. In combination with the Ishikawa diagram, the Pareto Diagram is used to divide the causes of the deficiency according to their importance, impact, and frequency of occurrence [2, 10].

After the root causes of waste, delays and waiting in the process are identified, there is time for the phase of proposing and implementing measures for eliminating the root causes of process deficiencies.

At the stage of proposing and implementing measures to eliminate the root causes of the deficiencies of the process, the quality management methods are again used. This work deals with the optimization of logistics processes without significant investments, and the kaizen managerial approach is best suited to this [3].

The essence of kaizen is simple and clear: kaizen means improvement and perfecting. Kaizen approach is the continuous, gradual improvement of processes and workers, which together brings great results. Kaizen can be considered a way of life and life philosophy. This approach is based on corporate culture aimed at improving by constantly searching and eliminating waste. Ideally, this improvement takes place in both the working and personal lives of each individual [8].

The kaizen approach aims to eliminate redundant stock and to streamline business processes [3].

Kaizen is not a complicated managerial principle that would only consist of meetings of executives, but, on the contrary, a significant part of it takes place directly in production. Workers work and solve their everyday work problems. Ideas for possible improvements of partial issues are recorded at the designated place and in the forms that have been prepared. The workplace becomes a place of observation and investigation of the occurrence and development of problems. It often happens that the worker comes out with an effective solution to the problem, but he is not able to present his idea clearly and formally in the form of an improvement proposal. Therefore, there are regulations and procedures for assessing, developing, evaluating and accepting employee suggestions by a qualified person responsible for deciding on the implementation of individual proposals and re-designing them as an internal improvement project [2, 8].

The advantage of kaizen approach is its small demands in terms of qualifications, technology, and investment. All that is needed to effectively implement this approach is a change in workers approach with the support of executives [8].

During the implementation of the improvement proposal in the spirit of kaizen philosophy the Quality Journal method, which consists of the following seven steps, is used to solve problems [3, 10]:

a) Identification of the problem – identifying the difference between the required target and the actual status. Facts based identification - target values / actual values. The most fundamental problem is selected and the priorities are set. The required target status, the term of the resolution, and the estimated benefits are defined. At

this stage, the histogram, the Pareto diagram, and the control chart are used.

b) Problem observation – the selected problem is further closely monitored. The causes of its origin and the problem bearers are identified. It examines the frequency of occurrence of the problem, its severity, its discoverability and its development over time. Histogram, line diagram, and Pareto diagram are used at this stage.

c) Analysis of causes of the problem – the hypothesis of what is causing the problem is determined. For this purpose, a cause and effect diagram, brainstorming, etc., are used. Subsequently, these hypotheses are tested by planning and performing experiments or by collecting new data. Individual causes are assigned a weight in terms of their impact on problems. Correlation and regression analysis, modeling, simulation, etc., are used for testing.

d) Proposal and implementation of measures to eliminate causes of the problem – there are two types of troubleshooters. One type is corrective measures that are immediate and focus on eliminating the consequences of problems. The second type of measures are preventive measures to address the causes of problems and prevent the problem. At this stage brainstorming and affine diagrams are used.

e) Validation of measures efficiency – comprehensive control of the effectiveness and magnitude of the impacts of changes. It is ideal to present the results in financial terms in contrast to the situation before the changes. Measurement and visualization are used at this stage.

f) Permanent elimination of causes –this concerns standardizing and permanently embedding of established changes into processes. Workers need to be informed about the reasons and benefits of change and to be motivated to adhere to new standards.

g) Report on problem-solving and planning of future activities – at last a final report is drawn up, detailing the progress and results of the problem-solving. The results should be supported by specific data. The report should also include a list of unresolved issues and suggestions for further action on the issue [10, 11].

2. Case study: Optimization of the dispatching process of final products from the warehouse of rolling mill with the use of road vehicles

This part of the article continues with a case study of using the methodology described above for mapping, improving and optimizing the logistics processes of the metallurgical company.

The case study shows the general procedure of application of the described methodology for the optimization of logistics processes of rolling mills, with an emphasis on the dispatch process with the use of road vehicles.

2.1 Analysis and mapping of the current state of dispatch processes

Data collection for the analysis of the current state of the dispatch processes took place in the form of structured interviews with the personnel of the rolling mill, the staff of the road transport dispatch department and the sales coordination and order management staff, and observation and measurement in the operation of the warehouse of the rolling mill.

Based on the collected data and knowledge resulting from the interviews and observations, a logistic process map of the rolling mill was set up describing the sequence of activities and related information and material flows from the moment the order was confirmed to the customer until the dispatch of the finished product. The logistics processes have been described in detail within the project, with particular attention paid to the information flows related to the execution of the order from its receipt to the end, i.e. to the dispatch of finished goods by road transport.

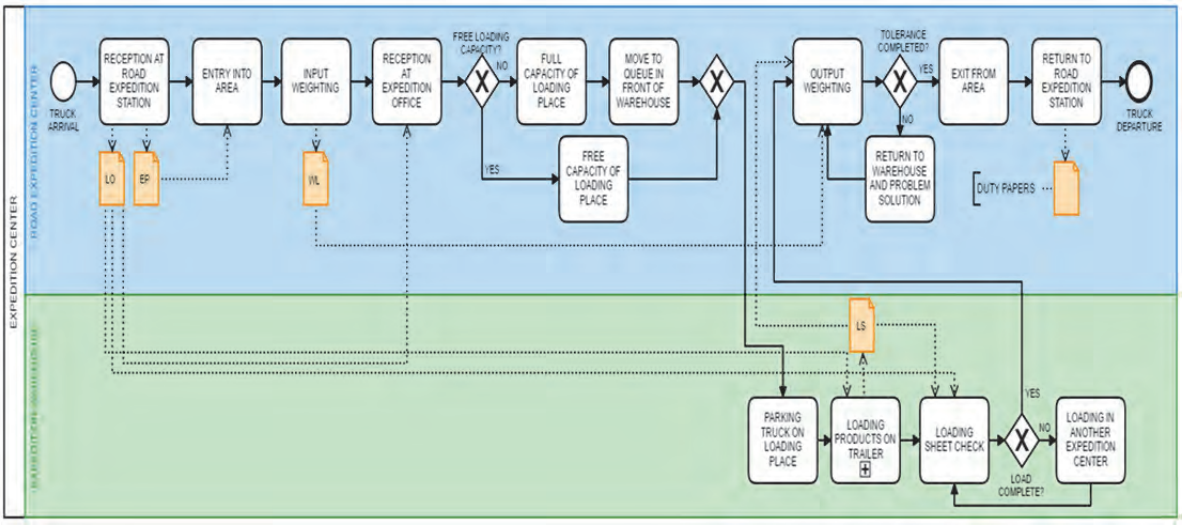

Fig. 2 Example of process diagram: Process of dispatch of rolled products by road transport. Source: our own data
Obr. 2 Příklad procesního diagramu: Proces expedice válcovaných výrobků silniční dopravou. Zdroj: vlastní

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Fig. 2 shows an example of a process diagram. The diagram shows process of the dispatch of rolled products by road transport.

2.2 Identification of root causes of waste and proposing measures to eliminate them

Based on the description of their logistics processes and detailed analysis assessment processes were carried out as described, as well as identification of weaknesses relating to these processes, which in daily practice usually result in unnecessary idle time due to redundant handling, delays in loading trucks, increased risk of injury or overload of the dispatch center. From the identified problems, an output set of problems was compiled, which was the input material for the analytical and design phase of the optimization.

Within the analytical and design phases of the project, identified problems were examined, classified into categories by major causal factors and for each problem a root cause was identified, by reduction or elimination of which a problem can be solved. For each identified problem, the consequences and manifestations that can be observed in the dispatch center, have been defined and described.

It has been found that most of the time delays during the dispatch process of rolling mill have their origins in the activities preceding the dispatch. As a result of the poor organization of the preparatory processes, a large number of trucks have to wait at the parking lot before the dispatch.

The most significant general issues in the dispatch process are the following:

1. Planning and organization of loading
2. Storing of products
3. Integration of information systems
4. Transport infrastructure
5. Preparation of delivery
6. The capacity of dispatch center
7. The layout of storage areas
8. Quality tests
9. Dispatch team capacity
10. Handling equipment

Based on the analysis of the identified problems, their root causes and consequences, the required status was defined and possible approaches to solving the problem and achieving the target state were suggested.

Fig. 3 shows an Ishikawa diagram illustrating the decomposition of the problem of delays during an dispatch to individual causes.

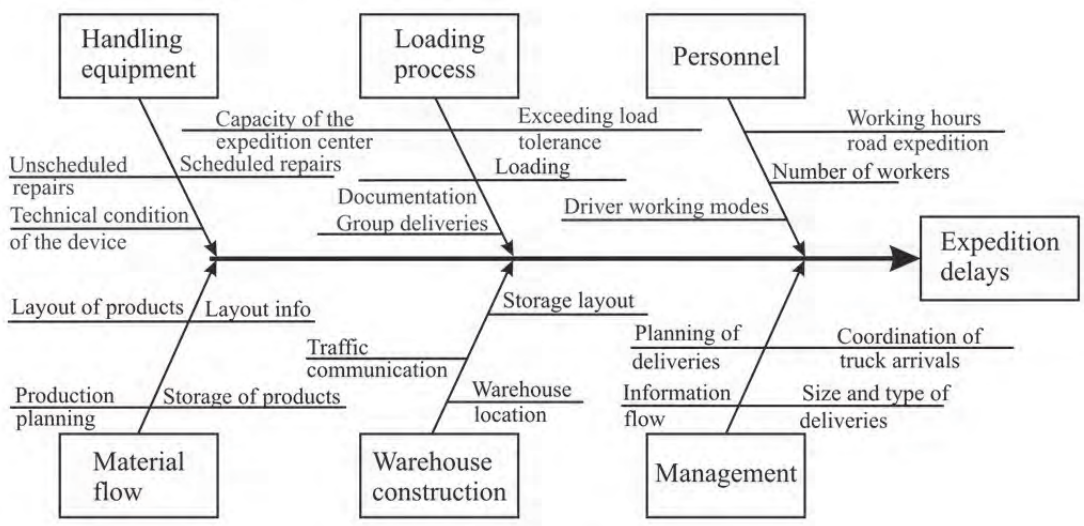

Fig. 3 Example of Ishikawa diagram: Causes of delays in the dispatch process. Source: our own data
Obr. 3 Příklad Ishikavowa diagramu: Příčiny prodlev v expedičním procesu. Zdroj: vlastní

In the subsequent phase of the case study, the individual problems were determined by the priorities of their solutions, for which a subjective point scale was used (Tab. 1). The table gives a brief description of the problem, the main causes, the most serious consequences, the target state and the design of the solution. The table is complemented by an assessment of the shortcomings in terms of priority, complexity, impact and removal costs. The problem prioritization was discussed with the company representatives.

Tab. 1 Matrix to determine priority issue. Source: our own data
Tab. 1 Matice pro určení prioritního problému. Zdroj: vlastní

#	PROBLEM AREA	PROBLEM DESCRIPTION	CAUSES	CONSEQUENCES		
1	**Planning and organization of loading**	Inefficient planning and organization of loading, respectively the order of waiting trucks.	Scheduling the order of loading of individual trucks irrespective of the complexity of loading and the total waiting times of trucks.	Higher average waiting time of trucks. Increased fines for delays during loading. Unnecessary warehouse operations.		
2	**Layout of storage areas**	Insufficient layout and assignment of product storage locations.	Imperfect system of products storage to designated storage locations. High warehouse occupancy at peak times. Lack of storage capacity.	Mixing of products at storage locations. Unnecessary handling of the material. Frequent searching for material during loading.		
3	**Capacity of dispatch squad**	Insufficient staffing of dispatch platoons at the peak of production of products with high hourly performance.	Call workers to other workplaces. Inoperative layout of storage areas. Failure to accommodate the number of workers according to the warehouse warehouse mode.	Interruption of loading and dispatch process due to attendance at other workplaces. Interruption of loading due to stockpiling of finished products.		
#	**PROBLEM AREA**	**TARGET STATE**	**SOLUTIONS**	**DIFFICULTY**	**IMPACT**	**COSTS**
1	**Planning and organization of loading**	Minimize average waiting times for trucks. Elimination of fines during loading. Optimal material flow.	Creating a dynamic system to determine the loading order of waiting trucks to reduce the total waiting time.	3	1	2
2	**Layout of storage areas**	A working system of storing products at designated locations for efficient dispatch.	Analysis of stored products and their turnover. Creating a methodology for storing products with a view to reserving places for high-speed products.	3	1	1
3	**Capacity of dispatch squad**	Efficient layout of staff capacities taking into account daily / weekly peak hours.	Revision of the number of workers in relation to the production and completion plan. Set dynamic shifts scheduling system.	1	1	3

As an output of this phase, a matrix of problem-solving priorities was created to visualize individual problems, or, the expected impact of problem solutions on the overall operation of the dispatch center, the complexity and investment intensity of their solution. To identify issues of the highest priority, a strategy has been adopted that envisaged the prioritization of problems with a large impact on the functioning of the whole system, which did not require high investment costs. On the basis of established priorities, proposals for solutions of selected problems from the category with the highest priority were elaborated.

Conclusions

The article presented a general methodology for mapping, improving and optimizing dispatch processes. The general improvement of the process starts by mapping the current state of the process under investigation using process diagrams. The next step is to identify deficiencies in the process and their root causes using quality management tools. The next step after selecting the most serious flaws in the process and revealing their root causes is to design and implement measures to eliminate these problems and their causes.

In the second part of the paper, a case study was elaborated on the application of this general methodology for optimization of logistics processes of the rolling mill namely the dispatch process of the rolled products with the use of road transport.

The case study demonstrates the suitability and utility of using modeling tools and quality management tools to optimize the logistics processes of the metallurgical company. The final output of the case study was a matrix containing a list of the most important process deficiencies, including their prioritization in terms of benefits and costs, and a brief outline of the recommended solution to the problem.

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Odstávky ovlivnily výrobu oceli v ČR v roce 2017, dovozy dosáhly rekordu v ČR i Evropě

V roce 2017 bylo v Česku vyrobeno celkem 4,6 mil. tun surové oceli, což je o 14 % méně, než v předchozím roce. Důvodem byly plánované rekonstrukce a technické odstávky ve dvou největších hutích ArcelorMittal Ostrava a Třineckých železárnách. Dovozy do ČR i EU byly loni rekordní. V budoucnu se zřejmě projeví i dopad zavedení cel na dovoz oceli do USA.

„*Je škoda, že se v loňském roce tuzemským producentům nepodařilo plně využít rostoucích cen ocelových výrobků, nicméně pro letošek jsme optimističtí, především díky ekonomickému růstu na našich nejvýznamnějších trzích včetně Německa a Polska,*“ říká **Daniel Urban, ředitel Ocelářské unie**.

Z čísel uváděných Ocelářskou unií jsou vidět rozevírající se nůžky mezi vývozem a dovozem, český vývoz poklesl o 8 % na 4,63 mil. tun, naopak dovoz vzrostl o 9,4 % na 7,24 mil. tun. Ještě patrnější je nárůst dovozu ze zemí mimo EU, kde meziroční změna činila 12 %. „*Pozitivně naopak vnímáme nárůst hodnoty českého ocelářského exportu o 6 %, na téměř 100 mld. Kč,*“ dodává **Daniel Urban**.

Globální nadkapacita trvá a stagnuje zahraniční obchod EU

Bohužel se stále nedaří řešit problém globální přebytečné kapacity, jejíž objem Eurofer odhaduje na 600 mil. tun. V roce 2017 se poprvé díky zavedení antidumpingových opatření zastavil prudký nárůst dovozu do EU, a to na rekordní hodnotu téměř 40 mil. tun. Situaci na evropském trhu ale může zhoršit přesměrování oceli z amerického trhu po zavedení ochranářských cel prezidentem Trumpem.

Pozici největšího světového producenta oceli potvrdila Čína (831 mil. tun). Na druhém místě je EU (168 mil. tun), následovaná Japonskem (104 mil. tun) a USA (81 mil. tun). Čína spotřebovala v roce 2017 asi 725 mil. tun, zatímco EU celkem 185 mil. tun.

„*Největší hrozbou pro férový globální trh s ocelí je státní politika dotací a daňových úlev či dokonce výstavby nové kapacity od Číny přes Irán až po Indii. Nová kapacita je ale to poslední, co dnes potřebujeme. Čeští výrobci se musí soustředit na výrobky s vyšší přidanou hodnotou. Jinak nemohou dlouhodobě konkurovat zemím, jejichž výrobci nemusí platit náklady spojené s obnovitelnými zdroji a emisními povolenkami,*“ dodává k vývoji obchodní bilance **Dmitrij Ščuka, generální ředitel Vítkovice Steel**.

- z tiskové zprávy Ocelářské unie -