THE ANALYSIS OF FLOWS IN LOGISTICS CHAIN ELEMENT

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Summary: The article discusses the problem of the regulation of goods and information flow in an enterprise participating as an element of the supply chain. The article underlines the significance of the system approach in the analysis of these flows both on the scale of an enterprise and from the point of view of the entire chain as well as the advantages for all of its participants.

Key words: analysis, logistics, flow of material goods.

1. The flows of goods and information on the example of a metallurgical enterprise

Each enterprise or business unit, the activity of which concerns production, trade or services possesses its own specific system of flow of materials, raw materials and information characterized by the kind of activity it runs.
These goods as well as the information may stay inactive creating the resources of an enterprise or database. While taking part in a dynamic process they create channels of goods and information flows. The remaining constituent parts of the goods flow system including, among others, fixed assets, create the infrastructure of these processes, if they serve or take part in the process of the flow of these goods and information.
The complexity of the logistics processes in an enterprise first of all depends on the profile of its activity. The industrial branch specifies the kind of existing production processes and the applied technologies, the size of the range of purchase, the kinds of production operations and the volume of final goods.
Polish metallurgical enterprises were designed when in the steel-making process the full-cycle production (the classical one) was in force. It influenced the size of enterprises, productivity, and the process of the flow of materials and raw materials and transport organization.
Figure 1. is the flow system of the basic raw materials in a metallurgical enterprise.
The knowledge of the system of basic raw materials flows in an enterprise plus the spatial layout with the system of transport connections constitutes the basis for its analysis, design and in-house transport organization.
All the logistics processes connected with the flow of materials, raw materials and final goods are accompanied by the information. Information flow for logistics creates a specific system, which can be defined as the structure of interrelated people, tools and procedures, providing a logistics specialist with the information for the purposes of planning, implementing and controlling [1.].

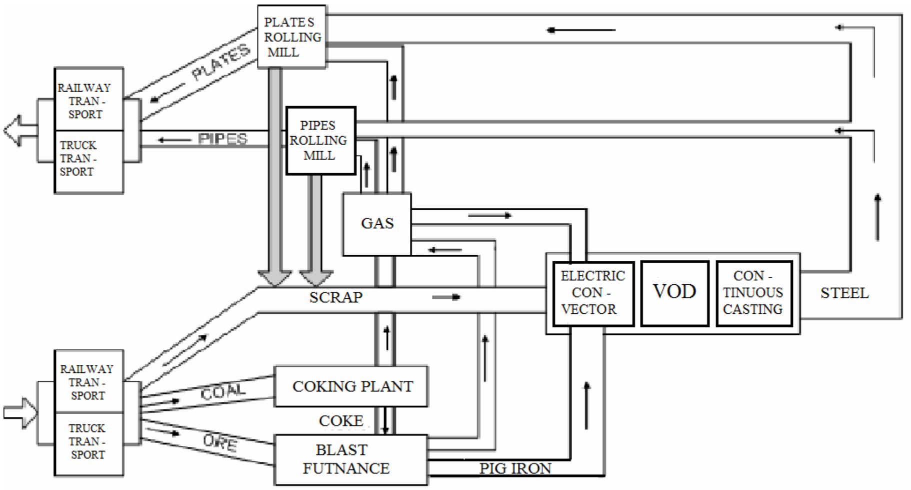

Figure 1. The system of the internal flow of material goods (materials and raw materials) in the metallurgical enterprise
Source: The Author's own study

The correctly functioning system of the information flow shows the ability of transferring information from senders to proper receivers. It allows for information storage and backup. Apart from the information passed directly (orally), to show the ability of flow, processing and storing, the system must possess the specific infrastructure, which depending on the necessary form of information, enables telephone calls, transport of documents, passing them via e-mail, reconstructing etc. The information system ought to satisfy the needs of not only its own enterprise but also be integrated with the system and the logistics chains of other enterprises.

While analyzing the processes of the information flow one must regard them on the strategic level, which is the level of planning as well as the operational level directly connected with the processes of the movement of goods within an enterprise and between enterprises. On the level of planning, winning, passing and processing information refers to establishing the size and kind of production a few months before, while taking into consideration external factors such as the possibility of sale of final goods, selecting proper suppliers and the dynamics of the market condition. The information flow on this level of the enterprise activity also ought to concern the coordination of the processes between the enterprises cooperating in/within the logistics chain. The operational level of the information processes refers to protecting and coordinating the logistics processes by supporting and supervising particular tasks and actions appearing in the process of their realization.

Information flow should also take place vertically joining following managing levels in the structure of an enterprise, taking over the functions of coordination and control of the run of the project realization.

The process of the information flow on the operational level originates at the time of determining Material Requirements Planning **(**MRP**)** and may take place before the movement of goods along with the flow and right after its completing. The main stream of information is directed by the technological process and carries the data concerning the number and time of the flow of particular elements in the system. Information flow in the opposite direction on some of the stages of the process results from the necessity of passing feedback or controlling or, in case of the appearance of disruptions, claims, data verification.

The used above term 'logistics chain' was analyzed by J. Witkowski [2.] distinguishing the terms: 'logistics chain' and 'supply chain'. He underlined the financial flows and traderelated aspect, which unlike the logistics chain additionally characterize the supply chain, in which, between the cooperating within different areas enterprises, the mining ones, the manufacturing ones, the trading ones and the service ones and their customers, the streams of products information and funds flow.

Understood in this way, the supply chain is the idea broader than the logistics chain. According to the authors in many interpretations, supply chains are regarded from the logistics point of view. However, one must be aware of the fact that enterprises cooperating with each other realize functions far beyond the logistics ones. Yet, using the idea, supply chains underline the key role of logistics functions connected with customer service, transport, warehousing, cargo handling, packing, customs service as well as transport organization and safety. The definition given above sufficiently characterizes the idea of the supply chain.

The constituent parts of the basic element of the distribution channel are two nodes describing the source and the sink. The element, which comes into being in this way, becomes the part of logistics chain when a few participants take part in the flow of goods (distribution), which simultaneously are both the raw materials receivers and the manufacturers of goods for other participants of the chain (the sink becomes the source).

The theoretical model of the operation of the element in the logistics chain can be described with three basic parameters: the efficiency of the source of distribution W, the absorptive power of the sink of distribution channel C and the capacity of the path P, which formulated with the same dimension, ought to be equal. In real conditions there frequently appear disruptions of flows between elements caused by objective factors or disorganization of production and procurement. The results are fluctuations of the efficiency of the source or absorptive power of the sink and the necessity of warehousing and over-production. The solution is the buffer warehouse, the capacity of which is formulated with dimensional weight or the number of units placed in a warehouse (the same as the remaining parameters) in relation to the time unit. This time is the period of the disruption appearance and it must be at least equal to the momentary increase of the source efficiency beyond the possibilities of the absorptive power of the sink. At this point one cannot forget about the traffic capacity, which must satisfy the maximum flow in the distribution channel.

Each element, as the constituent part of the logistics chain, requires the flow control. Defining the control and its methods it is necessary to adopt the proper criteria of assessment. The basic criterion can be the time or the cost of the flow, though it is also necessary to take into consideration its influence on the entire chain being the object of the examination and the total costs.

The material flow control between the supplier and the receiver is based on the synchronization of this process. This involves continuous information flow in order to establish the optimum moment for transporting the ladle by conscious slowing down or accelerating the technological process both with the sender and the receiver of transport. Coordinating the streams consists in e.g. establishing the order of flows, the size of one-time supplies of streams depending on each other, which results from the order and sequence of the production process. Additionally, taking into consideration the external flows to and from individual elements of chains, the coordination allows for the distribution of traffic evenly preventing conflicts and flow blockade.

2. The system analysis.

The system analysis of the problems connected with functioning of an enterprise positively influences the global results of its activity. It also allows to eliminate the sub-optimization operations (pseudo – optimization).

The task of the general systems theory is to define the basic rules which can be applied in systems in general. The system theory as the logical and mathematical field enables taking into consideration a dynamic character of an enterprise and mutual bindings/relations within an enterprise. It also provides the framework for operation planning and predicting its immediate and far-reaching effects and understanding unpredictable consequences as they appear [3.].
The idea of the systems theory is the analysis of the phenomena concerning the entire object selected from the environment along with its constituent parts with regard to its most important features. Its task is to formulate mathematical models, algorithms of the process sequence, on the basis of constant cause and result connections.
The process of recognizing the system is connected with the system analysis which is defined as the research method based on regarding the analyzed objects as the constituent parts of a specific system, acknowledging that the system, thanks to multidirectional connections combining its constituent parts, shows the ability of self-controlling its own activities and affecting its environment. The system analysis adopts the thesis that the system testing is impossible without taking into consideration the overall conditions, in which it operates and exists [4.].
To sum up, the system analysis enables solving complex, weakly-structured organizational problems, which cannot be entirely modeled mathematically. It should also take into consideration the influence of the environment on the system.
While building a model we usually try to understand complex reality, presenting a selected aspect of the system or its part, most often in a simplified way, omitting some details, unimportant from the point of view of the objectives of modeling, presenting the analyzed object in the form other than the one in, which it actually exists [5.].
For the proper choice of variables of a model, it is necessary to have a good theory of the phenomenon being the object of the analysis, which unambiguously settles the problems of the choice of variables. The situation becomes complicated when such a theory is unavailable. Then, it is possible to make attempts to solve complex logistics problems with the use of models, remembering it is also necessary to make use of experience and intuition.
Taking into consideration the modeling of a specific object which e.g. an enterprise or any of its part is, we have to learn its system of functioning and to analyze the processes which take place in it and the bindings between its specific elements.
An example tool of the system analysis is Data Flow Diagram. Presented in the form of a diagram, a specific system model shows processes, data flow between processes and data warehouse used in these processes.
DFD, apart from the statistical map of the system, is also the model of its functioning, because all of its elements work the same as in the real system. In other words data flow in a model reflect the data movement in the real system, and the model processes work with the same source data as in the real system and they produce the same sink data [6.].
Building the DFD model is to be started with marking the range of the system, which will be the subject to the analysis and modeling. The context diagram (the basic diagram marking the range of modeling) fulfills functions defining the system range. It enables paying attention to the scope of the system since it identifies cross-border data flow informing what kind of data enter the system and what kind of data the system produces. The data are supplied to the analyzed system from another external system (an individual or an organization) called a terminator (graphically marked as a rectangle). Similarly, the data processed by the system get to the terminator being the receiver of the sink data. Data flow between the terminators and the processes within the system are called cross-border flows.
The functioning of the system model takes place by collecting external data by the cross-border flows and processing it into the sink data. At the same time the decision processes concerning the in-house transport are activated. All the choice (decision) processes are based

on the iteration procedures (algorithms in the form of mini-specification). Building the model and its processes are far from the kind and the organizational structure existing in a specific enterprise. It allows for verifying the model on the basis of the actual system and in the process of its streamlining or its functioning in the context of e.g. costs, transport duration.
Gradual decomposition of the context diagram to the diagrams of the lowest level allows for the analysis and understanding the elementary processes not undergoing further decomposition. Reaching the moment when all the system processes are in the elementary form and when we note compatibility with regard to the amount and the kind of source and sink data (in the selected parts of the model) on all the levels of its decomposition, we may regard the system model as the correct one.

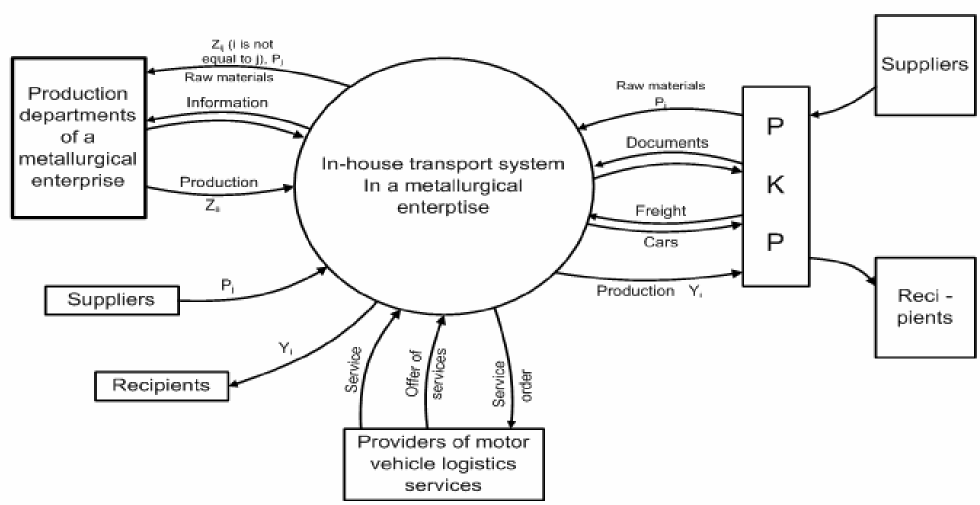

Figure 2. The Context Diagram
Source: The Author's own study, on the basis of [7.]

Figure 2. shows the context diagram marking the scope of modeling where: P_j – raw material purchase for j-th process (the sink), Z_{ii} – the exit of the main product out of i-th process (the source), Z_{ij} – for (i not equal to j) part of the main product of i- th process (the source) feeding j-th process (the sink), Y_i – part of production of i-th process (the source), sold externally as a final product $Y_i = Z_{ii} - Z_{ij}$.
Knowing the phenomena appearing in the examined system and its most significant parts, taking part in the basic processes of the analyzed object, we are able to, with the use of the constructed models, simulate the quantitative-qualitative changes inside of it. Simulated changes before being implemented into an enterprise must undergo the verification with regard to the compatibility with the technological process, goods and information flow, relations on the border: the system – the environment as well as the possibilities and economic effects of an enterprise.
An enterprise operating on the market, participating in the flow of goods and final goods becomes more or less well-organized element of the supply chain. To satisfy the needs of the market with regard to the efficiency of material goods flows in an enterprise, not only on account of the correctness of the functioning of the logistics system, an enterprise must participate in the logistics chain in an organized way while creating an element.
The justification of running the analysis of material goods flows in an enterprise is the assessment of the efficiency of these flows with regard to their intensity and duration, and

understanding its functioning with regard to the possibility of conducting the system changes in it.
Building the logistics system model of such an enterprise allows for simulating the effects of possible changes adjusting logistics processes in an enterprise to the requirements of the logistics chain. On the scale of an enterprise, using knowledge from the conducted analysis and the possibilities the model of the logistics system gives, allows for streamlining it with regard to e.g. lowering costs and shortening the time of the material goods flow.
In the model of an example metallurgical enterprise, keeping the requirements imposed on a participant of the supply chain, there were the changes introduced, which, when economically verified, would bring about the savings of 3986.64 PLN a day on the scale of the enterprise (7.6%) [7.].
It is necessary to emphasize in here that these changes were made with the use of knowledge on the specific character of the examined object and they would not involve bearing any additional investment costs and they did not show dependence on each other (the mutually excluding ones). In case of lowering the total costs of the supply chain processes it is required to use, the same in all elements, the system of the system of records and the booking of deliveries [8.] and its entire monitoring, which sometimes takes place at the expense of the loss of independence of a business unit.

Conclusions

Knowledge on the functioning of the supply chain, in which an enterprise takes part as an element, is essential in the present economical situation, Apart from the significance which refers to the minimization of time and costs of the logistics processes of enterprises, a vital role for the entire supply chain plays as well the quality of the customer service, its value added and the financial results of the selected elements. To gain the knowledge on the above elements, the proper tools are the system analysis and the model of system functioning and the possibility of simulating the effects of the implementing changes in it. Combining the decision process and the possibility of the assessment of its effects diminishes the risk of mistakes in the enterprise management.

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