Total Logistic Plant Solutions

Dušan Dorčák [1], Július Lišuch [1], Romana Hricová [2]

[1]*Development and realization workplace of raw materials extracting and treatment, Technical University of Kosice, B. Nemcovej 32, 043 84 Kosice, Slovakia*
[2]*Department of Manufacturing Management, Faculty of Manufacturing Technologies with a seat in Presov, Technical University of Kosice, Bayerova 1, 080 01 Presov, Slovakia*

Abstract: **The Total Logistics Plant Solutions, plant logistics system - TLPS, based on the philosophy of advanced control processes enables complex coordination of business processes and flows and the management and scheduling of production in the appropriate production plans and planning periods. Main attributes of TLPS is to create a comprehensive, multi-level, enterprise logistics information system, with a certain degree of intelligence, which accepts the latest science and research results in the field of production technology and logistics. Logistic model of company understands as a system of mutually transforming flows of materials, energy, information, finance, which is realized by chain activities and operations.**

Keywords: **Total logistics plant solutions, Information, Digitization, Hierarchical balancing optimization model.**

1. Introduction

Nowadays information is a powerful tool in the hands of executives, managers of prosperous companies for determining and ensuring the fulfillment of their vision and goals. But information itself cannot exist without other subjects, for example logistics. Logistics itself is a system, respectively network of interconnected activities that aim to control the flows of materials, people and information [1]. Information logistics is possible analyze as system of information functions and information procurement, but also as independent area in the system [2].

DOI: 10.18421/TEM51-15
https://dx.doi.org/10.18421/TEM51-15

Corresponding author: Romana Hricová:
Dušan Dorčák, Július Lišuch: Technical University of Kosice, Slovakia

Plant logistics includes very detailed system of organization and implementation of the complex operations, which cannot exist with out effective and functional system.

The issue of processing and provision of information and logistics are currently still relevant. The emergence of new technology, especially information technology moves forward the informatics, allowing increase of the quality of making decision at all levels. Because of it, it was necessary to create a universal tool for managing the entire process as the market requires the possible widest range of products, short delivery time, low prices and continuous products innovation, while maintaining high quality from the plants. Special attention must be paid to coordination of all components of production, including optimal management, planning and scheduling in the form of the selection of an appropriate strategy. Due to the fact that there are significant differences of the processes, the practical application have their own characteristics too.

The role of information systems and logistics is to ensure the high quality of the decision-making process leading to cost optimization while maintaining product quality [3]. In light of the above is the information system together with logistics strategy to sort a sequence of activities in the process of securing goods and services leading to optimal in terms of achieving the objective criteriaTo support processes - to further the objectives and vision of the company and logistics ensures and optimization, is necessary to simplified information system.

Plant is managed logistically - if it applies a collaborative management style, fully subordinated to meet the needs of customers with long-term profitability. Activities of all participating departments are logistically connected and aligned (integrated) in order to achieve a synergistic effect in logistics.

2. Theoretical background of problem

Information represents the creation and use of the digital world. In current practice there is the material world and the digital one. World existing in digital form is a virtual world. Virtual objects are divided into objects which reflect external appearance of reality (paintings) and objects reflecting the internal structure of reality (models). Contrary to virtual reality, which is entirely based on artificial computer-generated content, the augmented reality allows users to see virtual objects in the context of the real world [4].

Informatics includes information and communication technology (dominates digital technology) and information and communication technologies (ICT). The entire information sector itself is divided into informatics, including information and communications, ICT and information, which includes the applications of informatics to individual areas [1]. With the increasing share of information increases the level of knowledge of the process, ability to control it, as well as the level of added value of product generated by information. Subject of information is creation of digital images and digital models of objects, creation methods for their manipulation and transformation and processing and application information for its real object.

Information allows not only exercising respectively simulate different activities digitally, but also their integration within and in relation to its surroundings [5].From the internal perspective, to allow increase the number of degrees of freedom and hence the flexibility of the system. External information system ties reduce its uncertainty.

Information conceptually changes the whole nature of production systems and processes. Current systems, which may be identified as first-generation systems, consist of information of existing processes. Future generations will be characterized not only conceptually by new solutions of individual elements, but also by their mutual integration.

Plants need information as their aim is to increase the quantity and quality of information obtained on materials, objects and processes. Later they are used for more effective management integrated throughout the management hierarchy.

Field solutions of information processes in manufacturing companies:

- direct and indirect acquisition of initial information about managed processes and their surroundings,
- creation of mathematical models and their application in the design and management processes,
- improvement of numerical and analytical methods forehead and fractional-order and controller design of fractional-order useful for modeling and process management,
- design of prediction management systems of specific technological processes,
- design of the logistics system of the production process,
- design of a system of economic management, raw material marketing and investment assessment.

An example of progressive technology of identifying is the RFID system. Its use in the processing of raw materials allows precise identification of individual doses and subsequent automated process control [6].

Comprehensive and integral building the necessary infrastructure allows better experimental and computational capabilities and in particular a substantial contribution in the possibility of visual communication in the virtual reality environment. Comprehensive information of processes and products forms the basis for a holistic and transparent solution of gradual digitalization of business processes:

- In the area of information and monitoring of processes, in which they are used principles of similarity and equivalence, the results are designed as mathematical models.
- Methods of predictive management allow optimized processes independently of the various hierarchical levels and apply the principles of internal control within the concept of "Advanced Process Manipulation". For the production of adequate mathematical models are used fractional modeling techniques; for complex systems are used replacement models, which can be solved by using a predictive way. Even very complex management tasks can be solved this way.
- A comprehensive business planning and management system is based on the formation of hierarchical balancing models, scheduling and forecasting models as well as their connection to plant data sources , including geographic information system and plant information system .
- For economic and marketing assessment processes and the processing of raw materials are used methods of strategic and tactical analysis focused on identifying requirements on investment in physical and human capital in terms of market needs and evaluating return on investments made.

3. Digitalization of processes

Digitization of processes in the form of a digital image of real plant and ensuring the use of the concept of the whole life cycle of the process, from design support and design, through planning to ensure the operational activities is the goal of this field. Digital image is created as a virtual equivalent of real plant enabling out its activities in the digital domain. The system consists of virtual objects, its mathematical models, data bases, and visual communication.

Digitization is represented in computer and information technologies integrated in the environment in which reality is replaced by virtual, computer models. Such virtual tests are very important as they allow, before the practical realization, verify all conflict situations and propose optimal solutions. Digitization of processes is primarily used for:

- Planning and designing of products and processes (technical and technological preparation of production, product evaluation and process cost and time analysis, production layout, etc.).
- Detail processes and validation of processes (technological and installation procedures, disposition and follow-up processes and operations, etc.).
- Modeling and simulation (simulation of material flow, process technology, virtual reality scenarios, ergonomics, etc.).
- Automation and Control (control logic, programming PLC, etc.).

Application of computer simulation in the operation of production systems can teach more about the processes and better understanding where in the production and logistics chain are generated the highest values. In processes plant logistics chain of the virtual reality environment, the aim is to link technical solutions to the economic ones. In practice, these are two views of the same process – technicalview and economic view. Digitalization of processes covers the analysis, design, processing and optimization of manufacturing processes, production technology, the area of timing analysis, design of manufacturing systems, but mainly the simulation during own production and internal logistics represented by ensuring material flow processes [6].

The primary area is digitized process that digitization enables to achieve significant benefits and these processes gradually expand and integrate. These processes form a suitable basis for the gradual digitization of other downstream processes. The integrated system custom logistics allows, in both levels - tactical as well as operational - gradually digitized and integrated into one system business processes.

Digitization of key technological processes allows using in their management a predictive approach based on mathematical simulation models, enabling the use of virtual techniques in their management. These processes, in most cases represent from technological point of view the bottlenecks. The ultimate aim of digitization is to create a comprehensive digitized model of the whole technological process of vertical links with the master model of an integrated system of logistics construction contracts. This ensures procedural plant integration - the cornerstone of the digital factory.

Parts of digitization on individual levels of differentiation are the partial processes, components, modules, equipment's, and technology units (group of connected sets). Processes are divided into technical and economic. Economic processes characterize the value aspect of the production process. Technical processes are divided into logistics and transformation. Transformation processes performed metabolic processing of raw materials. Logistics processes provide the link between the transformation processes. Substantive technical processes are divided into:

- rheological,
- hydro mechanical,
- thermodynamic,
- mechanical.

Components are associated functionally as the partial processes and spatially components are integrated into modules of input, output and labor. Synthesis modules create aggregate.

4. Predictive control system

Technological processes are complex processes with a large number of partial processes and variables with different types of control algorithms, optimization, planning and decision-making. Predictive control system of technological process represents a calculation sequence management interventions that minimize the criterion of the set management, given the limitations of management and controlled variables. Main features of predictive control are:

- Allow to take into account the large traffic delays, inverse response and a relatively complex process dynamics.
- Offset the impact of measurable and immeasurable disorders.
- They are formulated as an optimization problem of management - taking into account border.

- Prediction of the output of system on the selected time horizon, based on a mathematical model of the system.
- Calculate of new action interventions based on minimizing objective function and the knowledge of mathematical model of the system.
- Correction of prediction output based on past measured outputs.

Prediction methods for process control (Fig.1.) now represent a large group of modern management methods with an increasing number of applications. Group methods that name Model Predictive Control (MPC) consists of methods used to calculate the guiding intervention of the mathematical model of the process of determining from the measured process data. MPC approach is based on solving two basic tasks:

- explicit prediction of the behavior of the process in the future,
- calculate the sequence of values management intervention to ensure the monitoring of the reference variable output.

Currently, there are a multitude of methods MPC processed in the form of algorithms built into the control systems and software products supplied by different organizations.

Creating a plant architecture planning and control system of manufacturing plant is based on the use of hierarchical balancing optimization mathematical simulation model of the production process and integrated logistics system of the construction contracts. This system respects the needs of the customer what allows efficient planning.

On the level of economic management there are activities aimed at creating innovative system of marketing and economic evaluation of macro and micro economic environment, which must respect manufacturing companies in their business, followed by establishing a comprehensive evaluation system of economic efficiency investments flexibly responding to changes and adapting business management to these changes.

5. Hierarchical balancing optimization model

The major article of logistics information system is a hierarchical balancing optimization model (HBOM). Local optimization does not guarantee achieving a global optimum, what means that correct solving of the subtasks may not mean that the whole solve problems are correct. In some cases, resolve some sub- tasks and their implementation impossible troubleshooting whole system [7]. The factis, that the solution is concentrated on evaluation of primary elements and their properties without judging interrelations and links between elements and their surrounding areas. HBOM consists of partial models based on material balance that can simulate needs for the production processes for different areas:

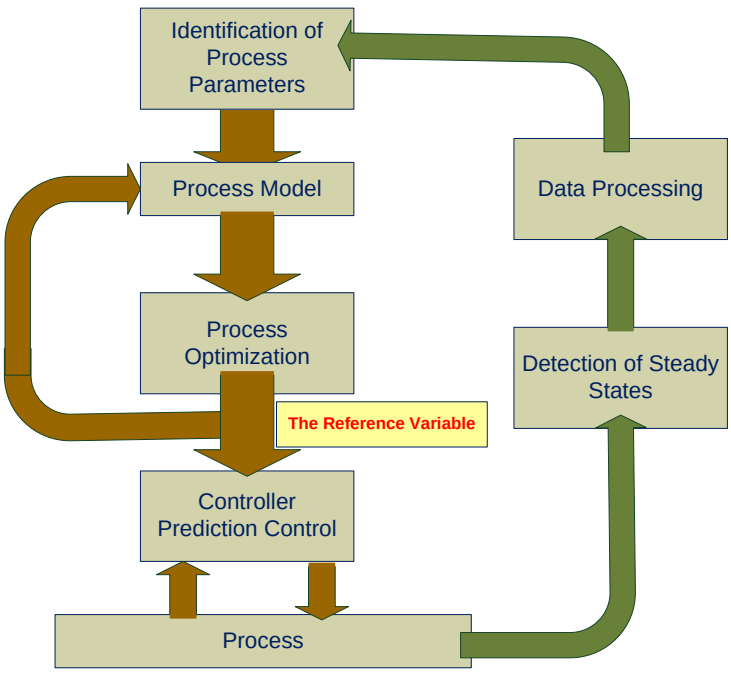

Figure 1.Implementation of prediction model technological process control

- model the basic technological scheme,
- material flow model of the production process,
- capacitance model,
- model energy balances,
- -model of human resources - personnel availability of the production process,
- maintenance model,
- economic, cost model.

HBOM use of the various levels of management is different. Its detail process grows towards the level of operational management. At the top management level, strategically, HBOM is used for creating strategic plan documents to determine the basic direction of the company. Production processes are defined for certain areas - functional nodes. As a rule, the information is general and with less overwhelming details that at this level of management and decision-making are not necessary.

Middle management level, the tactical one, uses HBOM level of technology and transportation routes. All information, which the material flow carries with itself (usually from the beginning of production) is recorded and evaluated at a supervised area. Documents from the model are input for module of planning and production management. Planning is an activity that distinguishes the different management styles.

Plant can be managed without a plan, but without a plan as it is not possible to assess the impact of individual actions and decisions, it is also burdensome to say anything about the future this plant.

The lowest level of management, the operational one, is characterized by detailed processing HBOM, It means that various changes and activities that contribute to the change of physic – chemical characteristics of material in the production process are captured event. describes each operation of technical equipment that contributes to these changes. From the perspective of the description it is more powerful. Its main benefits are the optimizing – innovative proposals for amendments to the technical or technological equipment and processes. Through HBOM we can simulate proposed changes, modifications or new procedures. Output brings the benefits it these areas:

- economic (savings),
- power (increase capacity, quantity),
- quality (better parameters of the product).

Collections of information and archiving are used in the evaluation of plans, resp. are the basis for flexible scheduling. Fig. 2.illustrates a pyramid with each HBOM module.

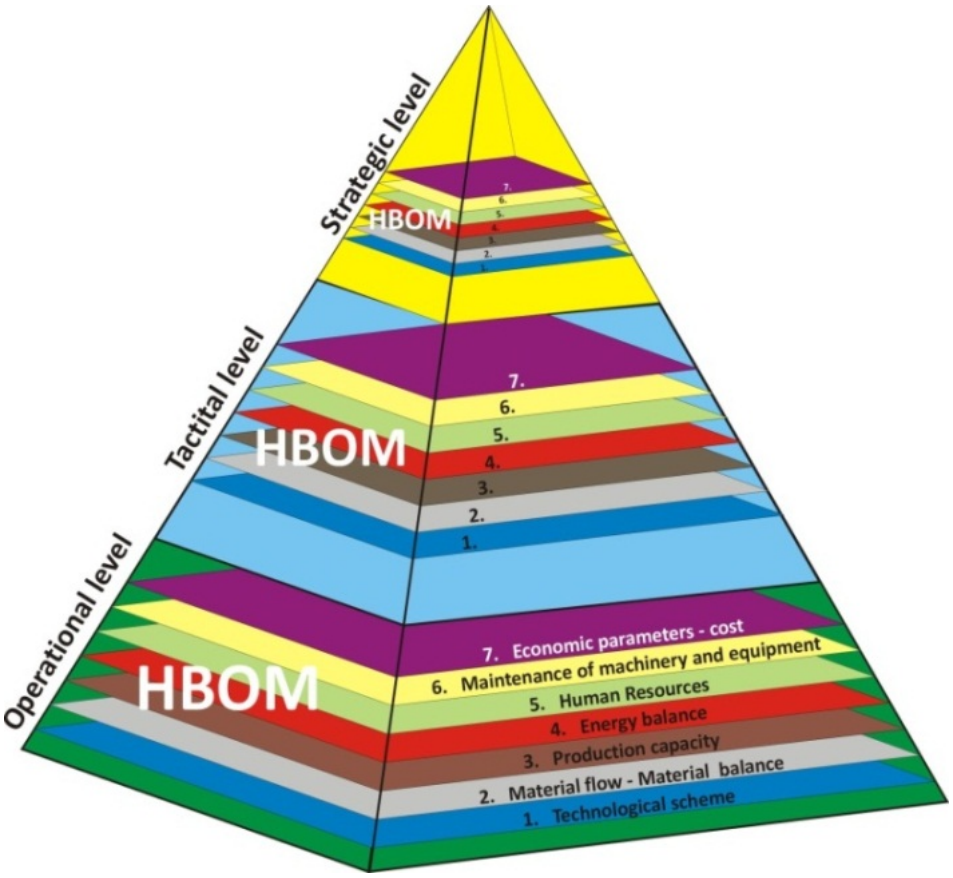

Figure 2.Management pyramid with modules HBOM

6. Complex logistical production

Currently in the production processes the dominant management system is a combined system, composed of software, the forward and feedback control. While in the technological processes prevail programmatically – feedback control, in logistics processes prevail programmatically – feed forward. The impact of the increasing competitive pressure and production quality requirements as well as the flexibility of the system is putting emphasis on the management of a predictive component. This is one of the causes of preference logistics and process approach in management today [3]. Draft management structure for the new concept using advanced technology, where is programmatically prefers predictive control. To this new concept reacts process management(self-organization, self-regulation), information and digitization management and implementation of logistics principles to the lowest hierarchical level processes (technological logistics).

Technology logistics is a logistics section focused on the area of technological processes. Hierarchically it forms its lowest level. Logistics processes, which form part of technological processes, are taking place in the technological aggregate. Logistics processes provide conversion processes and provide the best possible implementation. Fig. 3. is a scheme TLPS.

7. Conclusion

Total logistics plant solutions are a solution, as its simple structure and rapidly application to information system of manufacturing companies provide instant results. Routing is strictly oriented to optimization of production with the main optimization criterion - the minimization of the cost of production. Interface and placement in the environment domesticated by IS are fast [2]. Automatic management operations are replaced by automated. Main element to decision-making and planning is HBOM.

On macrologistics level(respectively strategic management level), HBOM is used for creating a strategic plan of company and also helps developing investment strategies. Its structure is „coarse-grained" the processing scheme is represented by technical and technological nodes.

Level of operational management - micrologistics - has further elaborated the technological structure and thus HBOM is represented by various technical and technological facilities. This level of control is the most important for annual, monthly planning and related evaluation plans. Custom packing is through HBOM and simulation in “Extended” scheduling to optimal doses and routes of production.

Technology logistics is represented by direct management, which is controlled by prediction. HBOM is detailed and depends on the technological structure of production.

TLPs use the latest logistics approaches that can optimize processes at all levels of management.

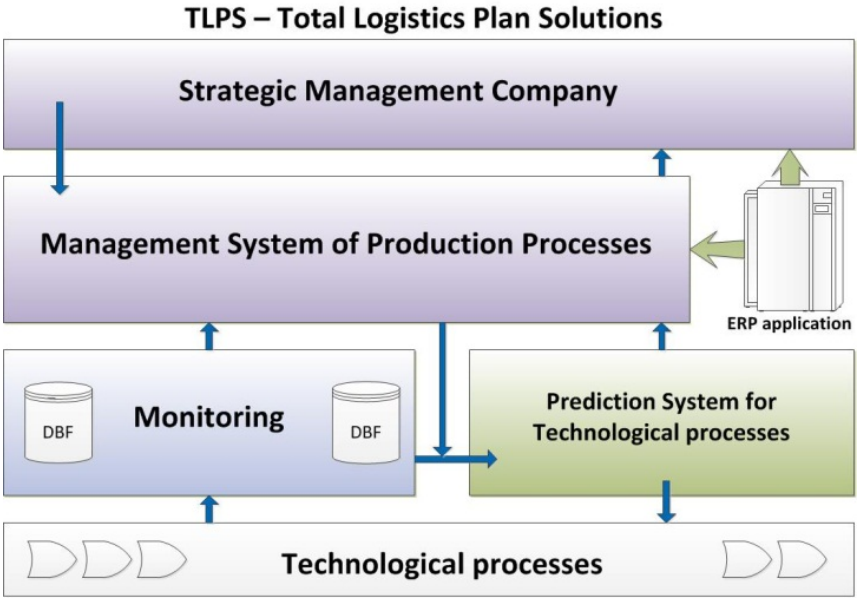

Figure 3.Scheme TLPS

Acknowledgements

This contribution/publication is the result of the project implementation "Technologically, logistically and environmentally advanced process of anthracite carbonization in VUM, a.s. ZiarnadHronom", supported by the Research & Development Operational Programme funded by the ERDF" (ITMS: 26220220168)

References

[1]. Dorčák, D.(2013). The Logistics Information System in Production Company. In: *14th International Carpathian Control Conference* (ICCC): 26-29. May 2013, Rytro, Poland: P. 44-48. ISBN 978-1-4673-4489-0.

[2]. Balog, M., Straka, M. (2004). , Logistics information system. *Transport & Logistics.* No. 6 (2004), 5-10.

[3]. Dorcak, D., Kostial, I., Husarova, M. (2011). Creating a digital factory concept on earth resources extraction and processing. In: *Advanced technologies in extraction and processing of earth resources*, Proceedings from conference, 2011, Slovakia, 51-54.

[4]. Cellary, W., Walczak, K. (2012). *Interactive 3D Multimedia Content: Models for Creation, Management, Search and Presentation*. Springer Science & Business Media, 2012.

[5]. Marton, D., Bednár, S. (2013). Approaches to complexity assessment of manufacturing process structures. In: *SAMI 2013*: IEEE 11th International Symposium on Applied Machine Intelligence and Informatics : proceedings: January 31 - February 2, 2013, Herľany, Slovakia. Budapest : IEEE, 2013, 233-237.

[6]. Zelko, M., Dorčák, D., Husárová, M., Olijár, A. (2010).The proposal of new technology within the concept of „invisible mine".14th *Conference on Environment and Mineral Processing*: Part 2: 3.-5.6.2010, VŠB-TU, Ostrava, Czech Republic. Ostrava : VŠB-TU, 2010, 197-203.

[7]. Babjakova, A, Repisky, R. Dorcak, D. (2010). Balance sheet optimizing model of the magnesite process modification in SMZ, a.s. Jelsava, 14th *Conference on Environment and Mineral Processing*: Part 2: 3.-5.6.2010, VSB-TU, Ostrava, Czech Republic. Ostrava : VŠB-TU, 2010 P. 213-219.