NEW CORPORATE PLANNING AND CONTROL SYSTEM CREATION FOR THE MAGNESITE EXTRACTION AND PROCESSING

[1]Július LIŠUCH, [1]Eva PITOŇÁKOVÁ, [2]Jaroslav GONOS

[1]Technical University of Košice, FBERG, Košice, Slovakia, EU,
julius.lisuch@tuke.sk, eva.pitonakova@tuke.sk

[2]University of Prešov, Faculty of Management and Business, Prešov, Slovakia, EU,
jaroslav.gonos@unipo.sk

https://doi.org/10.37904/clc.2022.4557

Abstract

The paper deals with the process planning structure of the complex magnesite processing, where capacity planning and production scheduling constitutes the meaningful and essential component of the product manufacturing control process within the whole its life-cycle. The result is a new advanced planning system proposal, which respond to a modern trends identified by European Commission for sustainable raw material processing area.

Keywords: Integrated customer logistics system, advanced management system, logistics, planning

1. INTRODUCTION

When creating a new business planning and control system, we must deal with a complex chain of company processes throughout their life cycle. The basic aspect to do so, is the hierarchical optimization of the process. With this optimalization we can find even in complicated system of processing raw materials a comprehensive optimum covering the entire value chain from exploration, through mining, treatment, primary and secondary (recycling) processing of raw materials to the creation of new products and technologies.

The basic definition of a company which deals with the mining of magnesite and its processing into caustic and clinker is as follows: it is a homogeneous production company, with significant division of the production process into continuous and discrete parts. In terms of material flow management, it is a combined system with the predominance of the principles of the PUSH system. Only a minimal part of the production process is managed on the basis of the PULL system. Today's market requires variety of products which puts pressure on the implementation of PULL systems in the mining companies. Production management is based on an operational approach and application of heuristics principles for problem solving.

The aim of the article is to point out new approaches to technology for complex processing of magnesite in accordance with the corresponding trends of the European Technology Platform for Sustainable Mineral Resources, which represent a high level of innovation and sustainability.

2. COMPLEX PROCESSING OF MAGNESITE - SMART FACTORY

The new approach for complex magnesite processing technologies involves a complex chain of processes in the mining industry and throughout its life cycle. The aim is to cover all of these standard key areas in accordance of the European Technology Platform for Sustainable Mineral Resources (ETP SMR). That means usage of the advanced technologies that represent a high level of intelligence and sophistication. In terms of planning and management system there are three key activities solved within the technology of complex magnesite processing: the area of company logistics, which should be part of the integrated customer logistics system, order processing according to customer needs and optimization of production process based on material, capacity and economic balance of production process with the creation of a hierarchical optimization

model. The complex magnesite processing is represented by the technological scheme according to **Figure 1**. In terms of use of advanced technology, the new concept should be based on a PULL system. In terms of needs of the new company concept, it is necessary to meet the following logistics requirements:

- eliminating the need for processes, flows, storages,
- integration of processes and equipment,
- storage flow,
- balance of stocks in storages,
- balance of production and transport in the production process,
- minimization, straightness, uniformity and fluidity of material flow.

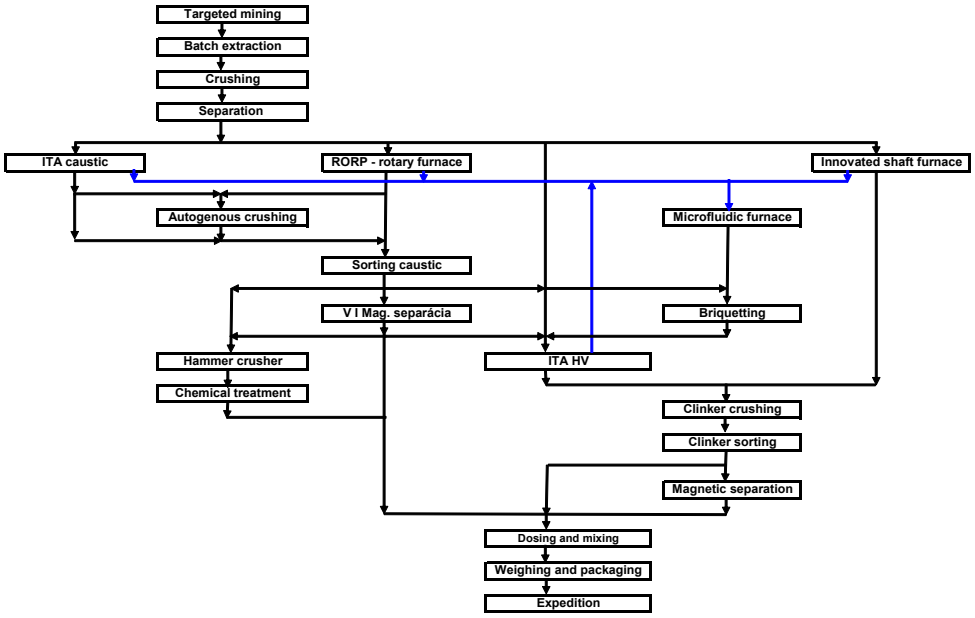

Figure 1 Technological scheme of complex magnesite precess

3. DESIGN OF AN ADVANCED PLANNING SYSTEM

The basic principles of the advanced planning system is the gradual informatization, digitization and smartization of magnesite processing processes in the mining company. These, essentially "helpful" techniques of obtaining a digital image of real processes in a company will allow completely different views of the company's operation in new market conditions. A digital and virtual view of mining operations will allow us to respond flexibly to customer needs, to change the optimal trajectory of material flow, to set optimal technological parameters to change the product portfolio, all according to customer requirements and needs.

2.1. Design of the structure and parameters of the management system and the information system of customer logistics

In the current global market environment, after the transition from production to sales and marketing, the logistics role comes into play. The main goal is orientation on customer and reducing overall costs. Finding a suitable logistics concept and applying it in practice can become an important way to achieve growth even in an area, where until now has been only a reduction in production and the closure of operations. The basic building brick of success even in traditional PUSH oriented industry are becoming customer oriented production and customer production, which means pull orientation. Under certain conditions, it is possible to

introduce a more efficient PULL system in this sector, in which the customer needs are fundamental. It determines what, when, how to produce and the company respects customer requirements amd follows them.

2.1.1. The structure of corporate logistics

The structure of the proposed company logistics system (CLS) consists of the performed logistics processes and the links between them and their surroundings. This structure is hierarchical, with horizontal ties (between elements on the same level) and vertical ties (defining relationships of superiority and subordination). Each level of the company's logistics system corresponds to the specific content and periodicity of the activities performed.

In addition to planning the main technological process, the company's logistics system (CLS) also includes the planning and provision of all necessary business service processes. (supply, storage, transport, energy, packaging and waste management, maintenance, distribution and especially material flow). In order to achieve maximum efficiency of production and service processes and in order to minimize production and logistics (warehousing, transport, etc.) costs, the proposed concept of mining and processing of magnesite considers using the latest logistics concepts and management philosophy, in particular:

- for customer logistics and company coordination - Integrated Customer Logistics System (ICLS),
- Pull system for material flow managment and production process,
- for the organization and orientation of the technological process - the concept of lean production (Lean Production, Outsourcing) and the CIM system - Computer Integrated Manufacturing,
- ERP - Enterprise Resource Planning system for production planning and scheduling,
- for the organization of customer-supply chains philosophy - Just in Time,
- for the area of maintenance management, the concept of TPM - Total Production Maintenance,
- for the area of quality management TQM - Total Quality Management, etc.

2.2. Structure design of the management system

Due to the growing competitive pressure and requirements for the quality of production, as well as for the flexibility of the system, it is necessary to place emphasis on the prediction component in management. This is one of the reasons for the preference for logistics and process approach in management today.

Based on this trend, the design of a management structure for a new concept of complex magnesite mining and processing is built. It prefers program-predictive management, process management concepts (self-organization, self-regulation), computerization and digitization of management and implementation of logistics principles to the lowest hierarchical levels of processes (technological logistics).

According to the material and time point of view The management or administration of a company can be divided into the following four levels:

- strategic management,
- tactical management,
- operational management
- direct management.

2.2.1. Strategic planning

On the one hand, company strategy as a concept is a set of decisions that determine the future company activity and goals of the company, the methods of organization of the company, as well as the external behavior of the company. On the other hand, a company strategy can be considered as a tool by which a company formulates its business focus and behavior towards business partners, taking into account its resources and

circumstances and considering the development of the business environment and risks. Addressing the issues of the company's long-term strategy requires detailed knowledge of all strategic components.

In order to strengthen its competitiveness, each company should create a certain knowledge base in each of the strategic areas, information base of possible approaches to problems or possible changes.

2.2.2. Tactical planning

There is not enough attention paid to solving problems of customer logistics in production companies. The term customer logistics is usually understood only as the registration and strict assessment of orders, or material. Capacity balance is performed before inclusion into the set of production tasks. There is a great lack of interconnection of customer logistics and other related company's activities, which would allow to perform custom logistics in full compliance with global company objectives, in accordance with customer requirements and while meeting all the requirements and limitations of the production and distribution process. The solution is to use a new integrated customer logistics system (ICLS), which allows production companies to optimize the creation of production plans, optimize the use of capacity and production resources, while meeting quantitative, quality and time requirements of customers.

ICLS within the new concept of address mining and processing of magnesite. The design of the new concept includes the mining and processing of magnesite and the design of a coompany's planning and control system, which is based on the use of geographic information system – GIS of the deposit, hierarchical mathematical simulation model of mining and raw material processing and integrated customer logistics system. This system will allow efficient mining and processing of magnesite while respecting customer needs.

2.2.3. Operational planning

Operational management has a specific position in the proposed management structure of the innovated process of mining and processing of magnesite, due to the fact that the emphasis in the entire management system is placed on tactical and direct management. By transferring part of the production scheduling tasks to the integrated customer logistics system, it will strengthen the active approach to production creation and create preliminary schedules by assigning production tasks (batches) to individual production processes, balancing them and aligning them with service company's processes at a tactical level.

The creation of production tasks - batches in terms of the type and amount of raw material required and the possibility of joint processing is left to the tactical level of management. On the other hand, strengthening direct management by implementing digitized and automated process management systems will reduce (objectify) the operation of dispatch management. In accordance with the proposed concept, operational management will be divided into three parts:

1) management of raw material extraction, including related service operations,
2) management of the raw material treatment process, including related service operations,
3) product shipping management

The specific requirements for operational management in the proposed concept also include:

- the requirement for a smooth change in the quality of the batches of mined and processed raw material, the aim of which is to prevent the mixing of different qualities as much as possible,
- use of RFID chips for automated process registration and monitoring,
- emphasis on the flexibility of the production process both in terms of performance and range,
- due to the continuously-discrete nature of the production process and PULL oriented multiple production of batches according to orders, it is necessary to use bottleneck planning, it is necessary due to energy consumption when scheduling production on heat generators.

2.2.4 Direct process control

Direct management ensures the immediate implementation of production tasks set by the operational plan in a specific process. Direct process control is realized through:

- ensuring information links of the process to its surroundings as well as inside the process,
- management of material and energy flows in the surroundings of the controlled process,
- coordination of process management in connection with other production processes,
- real-time process management.

2.3. Orders processing based on customer needs

Part of the above mentioned ICLS is an algorithm. Its role is to process orders according to customer needs, assess them and plan them in production and mining requirements. This will make the entire processing process more visible and optimized for all customer requirements and it will be well planned according to the mining requirements. Mining process will have attributes of address mining, which will be strictly oriented according to customer orders and their specific requirements.

We are considering four types of quality in the new planning system. The types and its possible use are shown in **Table 1**.

Table 1 New quality distribution of magnesite

Quality	Content MgO v %	Application
A	> 42	Processing for high quality products with MgO over 90%
B	39 (40) - 42	Processing for medium quality products
C	36 – 39 (40)	Processing into agricultural products and sands
D	< 36	Sand, base

Table 2 Possibilities of internal order satisfaction

Usage priority	Available time [hours]	Total time [hours]	Activity description
1	1 - 8	8	Using of already finished production stored in trays
2a	24 - 48	56	Unsorted clinker before magnetic separation treatment plant,
			Grain size of the processed heat aggregate
2b	+ 24	80	Crushing finished production means increased costs
2c			Mixing the finished production according to the required quality means an increase in costs depending on the mixing recipe
3	+ 24	124	Filling into furnace - affects the composition of unsorted clinker
4	+ 24	148	Open stocks located in the mine will be used for moving from the mine to the treatment plant
5	+ 72	220	Mining plan based on GIS system

By cumulating all customer's orders for a given planning period, a product matrix will be created, in which the quantities of the product are registered according to its quality and granulometry, and thus internal orders are created. Followed by assessment of internal orders. During the assessment, it is determined whether it is possible to produce the order in a given quantity and in a given planning period, as well as the expected date of production within the planning period. The exact procedure for satisfying the requirements of a given internal

order is shown in **Table 2**. After determining the source of the material with which the internal order will be realized, the entire production process is simulated using a hierarchical balance model. Whenever discrepancies in production will appear, it is necessary to intervene with a planner who will implement the solution to the problem.

When solving all customer needs, we can change the source of the material, the time of production, the size of the internal order, etc. After removing the discrepancies in the plan, it is necessary to run the simulation again. If the simulation is successful, the assessment of the order is completed.

After the distribution and assessment of all customer orders, new plans for subsequent processing, shipping and other service will be prepared.

2.4. Hierarchical optimization model

The solution of the hierarchical optimization problem is based on the idea of creating:

- material flow model of the production process,
- capacity model,
- economic model.

These three models create a simulation hierarchical model. On the basis of the material flow model we can create a capacity model and calculate all costs of the production process. In contrast to the classic simulation approach, where by simulation of material flows we could identify only the time characteristics and parameters of the production process, the hierarchical simulation approach extends the simulation of the material flow and its time recalculation by material, capacity and economic balance.
Optimizing the production process, leads to a solution of a multi-criteria optimization problem.

The actual solution of multi-criteria optimization of the production process is in the proposed model divided into three interconnected parts and levels:

1) first level – the level of material balance which solves the optimization of material flow,
2) second level - the level of capacity balance, which solves the optimization of the use of existing production capacities for the needs at the first level of the optimized material flow,
3) third level - the level of the economic balance, the cost optimization is used, because most management interventions in the organization of material flow, input parameters, equipment settings will result in an increase or decrease of costs.

In addition to a comprehensive assessment of the impact of optimization measures on the production process, the hierarchical optimization model can be used for other business tasks:

- for the analysis of the production process and next synthesis of rationalization actions,
- to assess the impact of investments on the technology and economy of the company,
- for model verification of the impacts of changes in technology, in the structure of inputs and outputs,
- to verify the reality and fulfillment of the operational plan, etc.

As part of the solution of the management and planning of complex magnesite processing, we created a hierarchical optimization model of complex magnesite processing, that's a new approach to the magnesite processing.

3. CONCLUSION

The result of the design of a new advanced planning system is the rationalization of production process, which results in concrete proposals for three key and cross-cutting processes of the mining company in the new

operating trends and conditions of raw materials processing and corresponding to modern trends set by the European Commission for sustainable raw materials processing.

REFERENCES

[1] DORČÁK, D., LIŠUCH, J. HRICOVÁ, R. Total Plant Solutions. In:*TEM Journal*. 2016, vol.5, no.1, pp. 97-103, ISSN 2217-8309

[2] DORČÁK, D., LIŠUCH, J. Linking management levels of the production process. In: *Applied Mechanics and Materials*: MMS. 2014, vol. 718, pp. 34-37. ISSN 1662-7482.

[3] SPIŠÁK, J., LIŠUCH, J. Technological logistics - tool of optimalization of heat treatment processes of raw materials. In: *Metal 2011*: 20. jubilejní ročník mezinárodní konference metalurgie a materiálů, 2011, Brno: Tanger, 2011, pp. 1-8. ISBN 978-80-87294-22-2.

[4] ORAVCOVÁ, E., ZELKO, M. Transforming the raw material industry with respect to the environment. In: *European Scientific Journal*. 2013, vol. 9, no. 32, p. 59-72. ISSN 1857-7881.

[5] SPIŠÁK, J. Technologické, logistické a organizačné prístupy v inovácii procesov získavania a spracovania surovín. Habilitačná práca. Košice: Technical University of Kosice, FBERG, 2008.

[6] SPIŠÁK, J., VAĽOVÁ, E., DORČÁK, D. Budovanie integrovaného systému zákazkovej logistiky v podmienkach spoločnosti Slovmag a.s. Lubeník, III. *Medzinárodná konferencia LOADO 2005, Logistika a Doprava*. 2005. ISSN 1451 – 107X.

[7] ŠINDLER,V. *Kapacitné plánovanie a rozvrhovanie výroby v procese spracovania magnezitu*. Dissertation. Košice: Technical University of Kosice, FBERG, 2010, p. 137.

[8] ORAVCOVÁ, E., ZELKO, M. The shift towards smart, green and integrated raw materials efficiencyIn. *Applied Mechanics and Materials : MMS*. 2014, vol. 718, pp. 105-109. ISBN 978-3-03835-377-5. ISSN 1662-7482.

[9] MALINDŽÁK, D., SPIŠÁK, J.,DRÁBIK, L., GROSS, I., GROSSOVÁ, S., KRAWCZYK, S., LENORT, R., NĚMEC, F., ROSOVÁ, A., STRAKA, M., STRAKOŠ, V. *Teória logistiky*. Košice: Karnat, 2007. ISBN: 978-80-8073-893-8.

[10] SPIŠÁK, J., TRUCHLÝ, M., NAŠČÁK, D., LIŠUCH, J. Complex research and innovation program of the raw materials thermal treatment. *In: Acta Montanistica Slovaca.* 2015, vol. 20, p. 209-219. ISSN 1335-1788

[11] SPIŠÁK, J. Structure of SMART Logistics Company System, Ing: CCIT 2014: Proceedings of the 2014 International Conference on Computer, Communication and Information Technology: Beijing, China, Paris: Atlantis Press, 2014. ISBN: 978-90786-77-97-0

[12] STRAKA, M., FILL, M. Information System as a Tool of Decision Support. In: *Periodica Polytechnica Transportation Engineering*. 2017, vol. 45, no. 1, p. 48-52. ISSN 0303-7800. Available from: https://pp.bme.hu/tr/article/view/9091/7213.