

MODEL FOR OPTIMIZATION OF TRANSFORMATION PROCESS THROUGH INTERNAL LOGISTICS

Ondrej Remeň, Andrea Sujová

*Technical University in Zvolen, Department of Business Economics, Slovakia,
e-mail: xremen@tuzvo.sk*

*Mendel University in Brno, Department of Forest and Wood Products Economics and
Policy, Czech Republic, e-mail: andrea.sujova1@gmail.com*

Abstract:

The paper deals with increasing performance of manufacturing companies in Slovak wood processing sector through optimization of internal logistics. Based on presumption that internal logistic process is a driving force of transformation process (TP), after interconnection with three basic elements of TP it is possible to develop a methodology for implementation of conception Industry 4.0. The aim of the paper is to suggest a pyramid model of procedure by optimizing basic elements of TP – people, processes and technology.

Key words: Industry 4.0, internal logistics, optimization, transformation process

JEL: M11, M21

1 Introduction

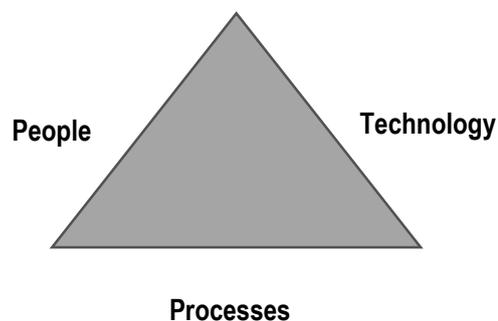
At the present time, the issue of performance increase and efficiency maintaining represents one of the main directions in the modern approach of the global business management. Sustaining competitive on the global market and at the same time maintain profitability is, due to the globalization process, a survival challenge for many enterprises in the European business environment. Global market globalization has brought about a certain degree of unification of input prices, which has resulted in a constriction of the handling space in the purchasing cost management. This fact also puts many enterprises at a border of their production possibilities where the enterprises no longer track input costs, but the cost of processes and their efficiency. Important factors influencing the efficiency and financial difficulty of the individual processes are the quality of the processing, the availability of information at the right time, the production time itself, the continuity and smoothness of the supply process and the associated time loss from the downtime.

The substance of process improvement is to achieve the change increasing process level and performance and process optimization is oriented especially to increase of value added for customer and company (Sujová, 2013). Through the optimization of the internal logistics, an enterprise can achieve the effectiveness of individual processes. Internal business logistics currently have a growing importance in the field of business management. It also bears the nature of a penetration process because it represents one of the main key processes but at the same time it has a supporting function for other processes.

Corporate performance is closely associated with the performance and effectiveness of the transformation processes itself. The encompassment of three basic elements of the transformation process is for the enterprise effectiveness necessary. The optimization of the transformation process in the current state, in which it is today, should represent the first step on the road to the Industry 4.0 concept. In order to prepare the wood processing enterprises for the Industry 4.0, it is necessary to have

all of these three elements mastered in the context of understanding the main issues connected to their respective narrow places (Figure 1).

Figure 1: Triangle of the three basic elements of the transformation process (TPET)



The importance of internal logistics lies in the just mentioned interconnection to other processes in the enterprise. If we design business processes as enterprise organs, we can design internal logistics as the blood that drives and supplies these organs with necessary nutrients (materials).

The Industry 4.0 concept is based on the ability of people, machines, devices, logistics systems and products to communicate and collaborate directly with each other. Everything works for total crosslinking. The reason for this crosslinking is the use of a huge amount of up to now unachievable and elusive information and data for the use in the considerably faster and more accurate decision making processes. The tight connection of products, equipment, people increases the efficiency of production machines and equipment, reduces costs and saves resources. Intelligent tracking and transparent processes provide companies with a consistent overview that will allow them to react flexibly and quickly to changes in markets. Industry 4.0 is built on two main pillars:

- Digitization - products, processes, equipment, services, etc.
- Application of exponential technologies

The main aim of this paper lies in a suggestion of a step-by-step pyramid model for analysis, optimization and monitoring of the internal logistics process which enables managing three basic elements of the transformation process and will lead the implementation process of the Industry 4.0 in the environment of the wood processing industry (WPI) companies in Slovakia.

2 Material and Methods

Theoretical knowledge concerning the issue solving in the paper was compiled of several kinds of sources. Information resources have been mostly foreign authors of scientific publications.

Under the term “internal logistics”, we can find all the control activities oriented to the control of material flow in the transformation process or in other words production. This approach requires a division of activities into (Emde, Boysen, 2012):

- Corporate Production Planning.
- Inventory management.
- Supply.
- Material handling.
- Information flow ensuring.

Internal logistics are interconnected industrial solutions that begin with the receipt of material to the warehouse and its subsequent identification, storage, handling and distribution to individual workplaces, monitoring of movement between these workplaces from processing and assembly, packaging, marking to dispatching (Takeishi, 2001). It was already mentioned that the internal logistic

process is the main driving force that is necessary for a proper and smooth enterprise process flow. Based on this assertion the first step goal lies in the identification of the internal logistic process and its current state in the environment of the WPI in Slovakia.

Optimization of the internal logistic process is closely related with investment activities in the field of technology, digitalization and R&D. A well-designed inter-enterprise network of logistics solutions significantly reduces downtime, increasing capacity utilization, continuity and smoothness of the transformation process. Therefore, businesses are no longer afraid of production costs, but from the inadequate deployment of their capacities over time, because the more time they lose, the less they produce. From the following is it possible to assume, that the basic parameter that determines the degree of effectiveness of this process is time. Internal logistic has a major influence on all three sides of the TPET. There exist plenty of tools and many foreign authors have already worked with the issue related with the optimization of the internal logistic process. Antunes et al. (2013) worked with the Six Sigma and Lean Concepts. Using Six Sigma together with quality tools and lean principles helped the identification of the variables that influence the raw material supply process and the definition of the improvement actions for a more efficient and effective defect reduction. The implemented actions reduced the defects in 80%, improving the customer service and increasing productivity. Dotoliet al. (2014) used the integrated techniques for internal logistics analysis and management. The method effectively integrates the value stream mapping (VSM) tool, the analytic hierarchy process (AHP) approach, and discrete event simulation.

The term optimization of people involves the methodology of employee education, motivation, remuneration and team building also the establishment of required information channels (Grosse et al., 2015). System of values, standards and habits influences the behaviour and performance of all employees (Hitka et al., 2015). In the term of people optimization are communication and information flow equally important to the mentioned social aspects. Internal logistic process in connection to people optimization is represented by information flow and the time that is needed to deliver critical information to the right employee. Downtimes that occur due to the misinformation among the logistic employees, machines and management, are crucial in the context of enterprise performance and efficiency.

Technology development increase has caused an increase of production possibilities (machines) which will produce faster and with high quality. However, not every enterprise is able to innovate in such fast pace in which is the technology development today. The fact that modern technology solution often becomes obsolete before their amortization time even expires, is considered today as the main issue for the most WPI enterprises. Enterprise should consider the structure of their technology park in consideration to the capacity-need, people disposition, energy intensity, capital intensity and environmental impact. The main goal lies in the optimization of existing technology park or in other words, retrieve the maximum continual performance now. Energy savings mean cost savings and lower environmental impact. It is necessary to mention that under the term technology we understand not only manufacturing machines but also buildings, IT, tools etc. Many authors have already dealt with this issue, such as Hrastelet al. (2007), Shang et al. (2010) and Zhang et al. (2016).

As for process optimization, process improving through internal logistics lies in carrying out positive changes which increase a process performance. The basis for improving the internal logistic process is the stating of key performance indicators of a process and their comparison with actually achieved values ascertained when measuring and analysing a process (Sujová, 2015). In the research paper of Sujová (2015), based on the survey results, the author came to the conclusion, that most of the investigated WPI enterprises are small sized (76, 5 %) and the dominative type of production is job-work and small-lot (74, 1 %). However, 23, 5 % of the WPI enterprises in Slovakia do not manage processes at all.

The internal logistic optimization in all three elements of the transformation process represents the main direction for WPI companies in Slovakia to maintain competitive and it could also represent a way to implement the conception of Industry 4.0.

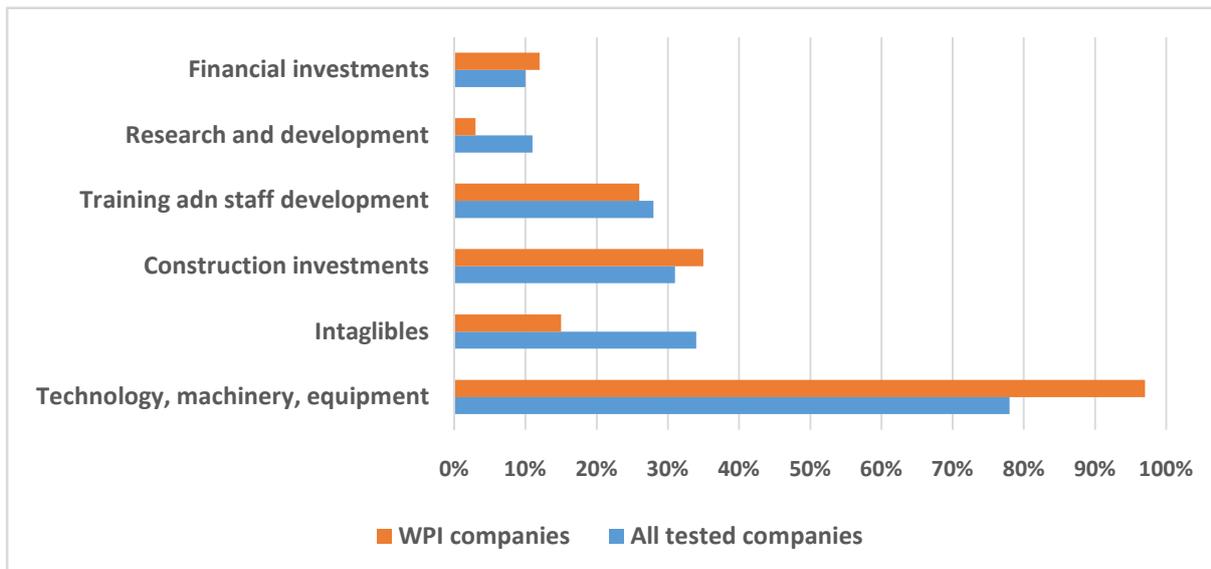
Based on theoretical knowledge, the results of existing surveys and researches dealing with the issue in companies of wood processing industry SR were summarized. Previous research was carried out in 2013 with the research sample of 165 enterprises from different industrial industries, mostly small and medium sized. In this paper a partial result of the research published by Merkova et al. (2015) is presented. Moreover, the primary quantitative research has been performed through questionnaire within solving the current scientific project. The primary research was focused on management of changes in Slovak enterprises from important industrial branches. In the first step, a database of enterprises consisting of 2 525 has been created. By means of Internet applications an on-line questionnaire has been created and distributed to enterprises. The sample size 525 responses is a representative sample in the research in a confidence interval 4% at a confidence level 99%. In the paper are presented partial results of wood processing enterprises which represent 15.7 % of the research sample and consists of 67 small-sized enterprises (1-50 employees), 6 medium-sized enterprises (51-250 employees) and 6 large enterprises (250+ employees) that have participated in the survey. Questions include all principles, methods and tools of change management known from theory and scientific publications. Data collection was carried out in the first quarter of 2017. Answers in questionnaires were processed and evaluated by chosen mathematical and statistical methods: absolute and relative frequency, descriptive statistics and contingent method.

3 Results

3.1 Results of Researchs

The optimization of the TPET through the internal logistic process is only possible with proper financial investment input. Merková et al. (2015) published the results of a complex research focused on the investment potential of WPI in comparison with other industries (automotive, engineering etc.) in Slovakia. The research confirms that the development potential of WPI in Slovakia is large, which is supported by the strategic asset of the country in the availability of wood raw material. However, the authors see the main issues in the form of investments, where intangible investments, which are crucial for better performance, are not a typical investment activity for WPI and in the process of investment project preparation and realization in companies of WPI (Figure 2.).

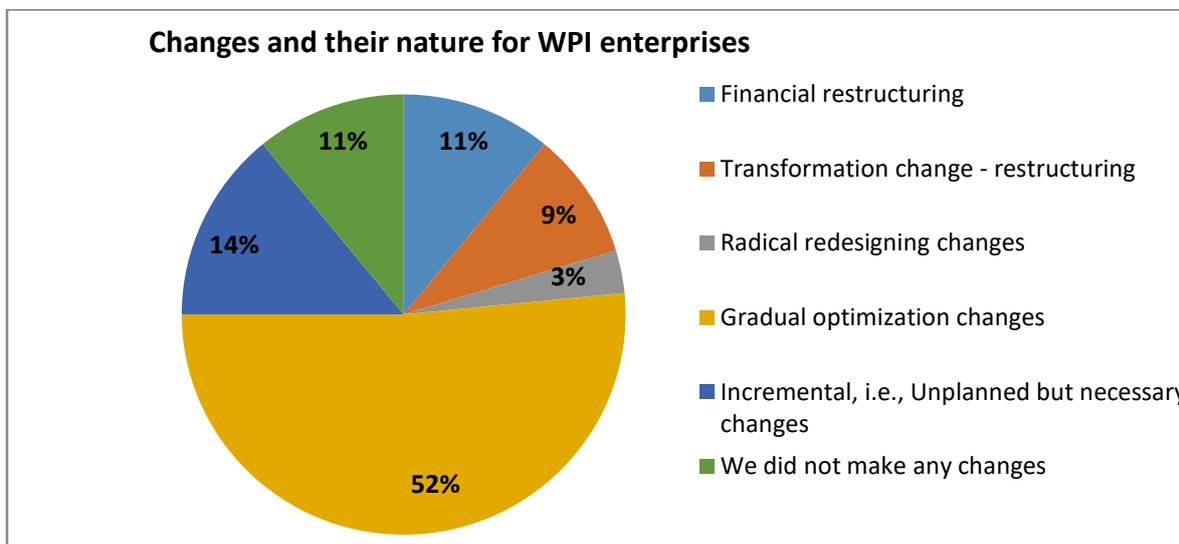
Figure 2: Investing directions – the most observed relative frequencies



Source: Merková et al., 2015

On the other side, a primary research carried out by authors and focused on the management of changes, can give a partial view on the issue of the current state of the problem. The Figure 3 illustrates how the Slovak wood processing enterprises has coped issues with changes in their environment.

Figure 3: Changes and their nature for WPI enterprises



The most frequent answer on the question “What types of changes have been made over the past 10 years?” was Gradual optimization changes. Therefore, it is possible to say that most of the WPI enterprises are adapting their production to the new trends and demands on the global market. Another question in questionnaire was “What processes were changed radically?” The answers follow that 22 % WPI enterprises performed radical changes in manufacturing and logistics processes.

After the analysis of the investment potential of the WPI development according to the research of Merková (2015), own research and the interview with consultant Ing. Michal Dic, it is possible to assume that the WPI in Slovakia has development potential for the implementation of the Industry 4.0 idea.

3.2 Proposal of TPET internal logistics build-up model

According to the materials it is possible to assemble a theoretical model of steps necessary for the WPI "evolution" in Slovakia. Due the analysis of theoretical materials and interview results it is possible to create a theoretical model of Industry 4.0 preparation and implementation steps for enterprises through the internal logistics optimization. This model is based on the assumption that the internal logistics process affects all elements of the transformation process simultaneously and cannot be developed for each side of the triangle particularly. The model is currently designed with four levels of integration (see figure 4). These levels can be in the future research renewed by others. Currently, the four levels are:

1. Internal logistics build up
2. Information flow securing
3. Data channel linking
4. Enterprise navigation and big data computing

The implementation of this model should result and ensure the smooth "evolution" of the enterprise in the context of the Industry 4.0.

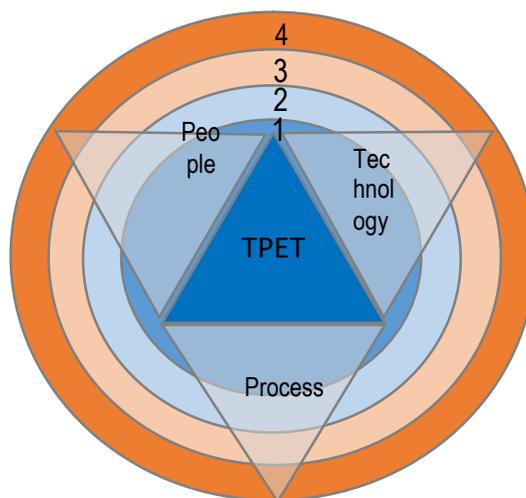
Internal logistics build-up level 1. This level represents the fundamental build of the process itself. In enterprise we can build the internal logistic from zero or optimize the current state, beginning with the analysis of the enterprise environment, process map construction, key indicator assumption, process FMEA development etc. At this level it should be possible to start the production and maintain the transformation process flow. On the other side, downtime occurrence frequency is due to low information flow among the employees often.

Information flow setting level 2. At this level there should be set a basic information channel for logistics employees who will provide a decrease in downtimes. The information channel should provide the employee with information that will allow supplying materials needed for production. These channels are developed particular for every department in the enterprise (cell phones, Kanban etc.).

Data channel linking level 3. This level is specific in the linking of all existing information channels (digitalization). Information is gathered in form of production data not only from internal logistic employees and their information channels but also from machines and processes from the whole transformation process. This should help to manage narrow spaces in the transformation process. Management has access to this data which can be used as support for decision making.

Enterprise navigation and big data computing level 4. At this point, the digitalization occurs in all elements of the transformation process. Big data are assumed and proceed. All items of the transformation process are linked in one network (IoT). A digital copy of the enterprise evaluates critical processes and optimizes them in a real time. Logistics employees are supported by an enterprise navigation system that use generic algorithms to calculate and predict the transformation process efficiency and therefore the downtimes in the production itself are reduced to minimum. Managers can monitor and affect the transformation process by real time interventions.

Figure 4: TPET - internal logistic build-up model



4 Conclusions

Industry 4.0 in the environment of WPI has a space for future development. However, the WPI in Slovakia should be more involved in the investment and innovation, particularly in the field of intangible assets, because today software solutions are necessary for the functionality of the transformation process in the enterprise. The WPI enterprises should take necessary steps before implementation the idea of Industry 4.0 into their everyday existence.

Without logistics, no production can work effectively. That's why internal corporate logistics is just as much more adaptable as it is. The term logistics in Industry 4.0 can be understood as intelligent automated systems that ensures smooth operation with minimal errors in the process. However, we must point out that a fully automated Industry 4.0 logistics chain is still difficult to achieve in today's conditions.

We recommend that future research activities will be oriented on the issue that is connected with the TPET and internal logistic in the WPI. Focusing on the current state of the internal logistics in enterprises of the WPI in Slovakia should represent the first step. In addition, the prototype model of the TPET – internal logistic build-up model should be remastered for the use in the WPI. This step-by-step model is only in the phase of development and therefore not definite. We also recommend focusing the future research on the issue of the digitalization, its state and progress in a connection on the Industry 4.0 idea in the WPI in Slovakia and the search for the key indicators that would represent a standardized view on the performance, flexibility and effectivity of the WPI enterprises.

Acknowledgement

This paper was processed in the frame of the projects No. 1/0286/16 and No. 1/0537/16 as the result of authors' research at significant help of VEGA agency, Slovakia.

This paper was as invited paper presented in the 4th International Scientific Conference „New trends in management and production engineering – regional, cross-border and global perspectives“ which took place in Cieszyn, 1 – 2 June 2017.

Bibliography

- [1] Antunes, D. L., Sousa, S. D. and Nunes, E. (2013) 'Using Project Six Sigma and Lean Concepts in Internal Logistics', World Congress on Engineering - WCE 2013, pp. 414-419.
- [2] Dotoli, M., Fanti, M. P., Iacobellis, G. and Rotunno, G. (2014) 'An integrated technique for the internal logistics analysis and management in discrete manufacturing systems', *International Journal of Computer Integrated Manufacturing*, vol. 27, pp. 165-180.
- [3] Emde, S. and Boysen, N. (2012) 'Optimally locating in-house logistics areas to facilitate JIT-supply of mixed-model assembly lines', *International Journal of Production Economics*, vol. 135, pp. 393-402.
- [4] Grosse, E. H., Glock, C. H. and Neumann, W. P. (2015) 'Human Factors in Order Picking System Design: A Content Analysis', *If ac Papers online*, vol. 48, pp. 320-325.
- [5] Hitka, M., Vetrakova, M., Balazova, Z. And Danihelova, Z. (2015) 'Corporate Culture as a Tool for Competitiveness Improvement', *Procedia Economics and Finance*, vol. 34, pp. 27-34.
- [6] Hrastel, I., Gerbec, M. and Stergargek, A. (2007) 'Technology optimization of the wet flue gas desulphurization process, supported with technical, economy and reliability based analysis', *Chemical&Engineering Technology*, vol. 30, February, pp. 220-233.
- [7] Anon., 2018. Industry 4.0: The main principles. Industry 4.0: Principy. Available at: <http://industry4.sk> [Accessed March 13, 2018].
- [8] Merkova, M., Drabek, J. And Jelacic, D. (2015) 'Evaluation of Investment Management and Business Performance in Wood Processing Industry in Slovakia', *Drvna Industrija*, vol.66, pp. 241-249.
- [9] Shang, K. H., Zhou, S. X. And Houtum, G. J. (2010) 'Improving Supply Chain Performance: Real-Time Demand Information and Flexible Deliveries', *M&Som-Manufacturing&Service Operations Management*, vol. 12, pp. 430-448.
- [10] Sujova, A. (2013) 'Business Process Performance Management – a Modern Approach to Corporate Performance Management', Conference Proceedings - Liberec Economic Forum, Liberec, pp. 542 – 550.
- [11] Sujova, A. And Marcinekova, K. (2015) 'Improvement of Business Processes - a Research Study in Wood-processing Companies of Slovakia', *Procedia Economics and Finance*, vol. 34, pp. 296-302.
- [12] Takeishi, A. (2001) Bridging inter- and intra-firm boundaries: Management of supplier involvement in automobile product development', *Strategic Management Journal*, vol. 22, pp. 403-433.
- [13] Zhang, J. G., Song, X. W., Chen, H. Y. And Shi, R. X. (2016) 'Determination of critical chain project buffer based on information flow interactions', *Journal of the Operational Research Society*, vol. 67, pp. 1146-1157.