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CRITICAL ANALYSIS OF PLYWOOD PRODUCTION SYSTEM MODEL

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Abstract
The article attempts to analyze the process of plywood production of a Polish plywood manufacturer. The aim is to describe the possibility of change in the production process in order to optimize production and minimize waste. It also indicates the possibility of minimizing production costs. Costs reduction could be achieved by modernization of technology and production equipment, as well as through the optimization of human resources management. However, in case of each particular change, the specificity of the whole industry and individual plant must be taken into consideration.

Keywords
management, organization, plywood, production, waste.

Introduction

Manufacture of wood products in Poland compared to other EU members is significant, and the key products in the field are wood-based panels [COM 474 2005]. For example, in Poland, in 2010, about 6.5 million m^3 of wood-based panels was produced, which accounted for 12% of the market share of all EU members and to this day, our country ranks second (after Germany) in Europe. Not without importance is trade exchange of Polish wood sector with other states [http://faostat.fao.org]. Competitiveness of Polish companies lies in the high technical level (modern and efficient technological lines) and the highly skilled workforce, which is directly reflected in the quality of final products.

Wood-based panel plants are a part of dynamic growing wood industry. In Poland there are several modern plywood and other wood-sandwich products manufacturing plants. The research conducted on innovation development of the companies indicates the potential for the deployment of new solutions. Such innovations are often of technological nature [1–3]. Nevertheless, they have to be adapted to the needs of both customers and the competitive situation on the market.

The aim of this study is to describe the activities of a typical plywood factory characterizing its production system model according to [4] (Fig. 1). The model will be critically analyzed in terms of:

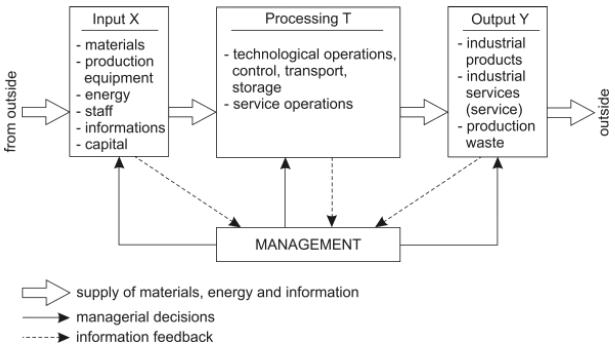

Fig. 1. Production system model (according to [4]).

1. significance of its elements in described factory;
2. discovery of new opportunities in both the technological and organizational sphere, that have the potential to extend the range of products, thus achieving competitive advantage;
3. implementation of the method of sustainable development based on the use of natural resources, which is particularly important in this sector.

Types of production models

In manufacturing plants the right planning of raw materials necessary to ensure production continuity plays a key part. The supply of raw material for plywood plants may be realized in two alternative ways: by storing the raw material in the long term (greater parts on the storage place) or buying it in batches for the current production. A method allowing for raw material demand coordination is material requirements planning (MRP). The method uses master plan of the production in order to plan the supply of raw materials. Extension of master production schedule enables the company to plan deliveries of raw materials at the precise moment when they are needed. According to [5] material requirements planning (MRP) is a computational technique used for the push paradigm that converts the master production schedule (MPS) into a detailed schedule for raw materials and components used in the end products. Parts are loaded into the AMSs based on minimizing the difference between the actual products and the scheduled orders released.

Another example of a production organization can be the properly planned logistics process. It allows for both proper planning of the raw material needed for manufacture as well as waste management system and transport policy.

In the paper, [6] it has been presented which elements a production system may consist of (Fig.2).

A model that takes into account all management aspects (resources, materials and logistics), thus allowing for the modification and search of savings is the production system model, which incorporates the technological and economic aspects (Fig. 2). The main task of strategic distribution logistics management is to produce competitive tools to support the company's competitive strategy [7].

In this paper the analysis will be conducted on a representative example of a wood processing company (plywood producer), for which the authors have identified main elements of the production system (Fig. 3).

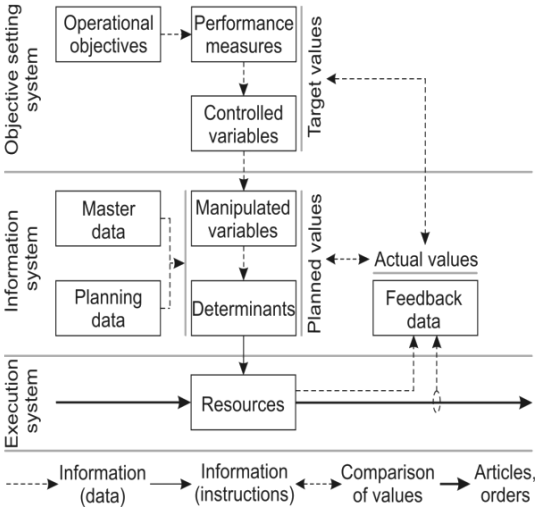

Fig. 2. Elements of the operational logistic action system [6].

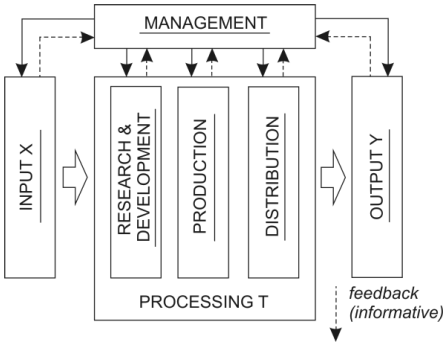

Fig. 3. Main elements of the production system in the analyzed plant (own work).

According to [8] in management process, it is possible to identify the following elements:

1. Leadership. The company's leadership system, values, expectations, and public responsibilities.

2. Information and analysis. The effectiveness of information collection and analysis to support customer-driven performance.

3. Strategic planning. The effectiveness of strategic and business planning and plans deployment, with a strong focus on customer and operational performance requirements.

4. Human resources focus. The success of efforts to realize the full potential of the workforce to create a high performance organization.

5. Process management. The effectiveness of systems and processes for assuring the quality of products and services.

6. Business results. Performance results, trends and comparison to competitors in key business areas-customer satisfaction, financial and marketplace, human resources, supplier, partners and operations.

7. Customer and market focus. How the company determines customer and market requirements and expectations, enhances relationships with customers and determines their satisfaction.

In the analyzed example, the plant buys wood raw materials and other materials directly connected with production (resins, hardeners, fillers etc.), as well as water, electricity, fuel, consumables (oil, lubricants) and cleaning agents etc.

The elements of input vector, affecting the realization of production assumptions are:

- plant capital,
- access to wide information,
- access to raw materials needed for production,
- the employees.

Plant capital comprises fixed assets (buildings, means of transport) and current assets. The share of managing and administration staff in all employees is around 15%.

Every organization builds its activity on gathering information essential to compete on the market. In order to realize the core business the analyzed company is trying to obtain information concerning the following:

- prices and quality of the competitors' products,
- new markets, including the demand for new types of products,
- possibilities of new technologies purchase,
- acquisition of skilled workers and qualifications improvement of those already employed,
- access to new suppliers.

Collected information allows for carrying out research on the plant development in the area of new technologies, waste management policies or distribution. The aim of the described model is to show possible changes that may arise when applying modifications in one or more selected areas of the plant.

The analyzed situation of plywood manufacturing process begins with the purchase of raw material in the form of logs or block. The raw material is stored in landfill yards. Manipulation of raw material (splitting the logs in length corresponding to the production profile) is done using transverse circular saws. The prepared raw material is subjected to peeling operation. Stripped material is processed hydrothermally. The plasticized material is processed on peeling machines to produce veneers. The acquired veneer' ribbon is divided with the simultaneous elimination of defects in full or incomplete sheets, which are then dried in a drying-through chambers. Undersized sheets are bonded and re-distributed to all forms. At the same time a qualitative classification of veneers is conducted, divided into two groups: veneer for the outer and core layers. Veneers prepared in accordance with established production are assembled in sets. The adhesive mass is applied by roller only on every second sheet. The completed sets are pre-pressed in the single-shelf cold press, and next, in the multi-shelf hot press with automatic loading and unloading. The produced plywood is conditioned prior to sizing and grinding. The final stage of production process is quality control. The plywood of poorer quality, which could be improved, is repaired. Finished plywood is stored in a warehouse or transferred for further processing.

The most important issue in the production of plywood is the policy of the company supplying the raw material (wood), obtained mainly from the supplier which is the National Forests (95%). The other sources are private forests and import. Price of final products (plywood) is strongly dependent on timber prices. Another important aspect influencing the final product is finding suppliers of other materials for the production, which not only offer low prices, but also meet high quality and ecology standards. The result is, among other things, reducing the need for disposal, thereby reducing costs and finding new markets and potential customers for the final product.

Compared to other wood-based material companies (particleboard, MDF), plywood industry is characterized by poor automation level. Because of that, it is important that workers should have experience in the range of wood processing.

Due to the opening of the electricity supply market, signing more profitable contracts became possible. On the other hand, the prices of other media (coal, oil, gas), purchased by the plant, are unstable with a tendency to increase.

Plywood plants are very flexible in its approach to customer needs. This entails the possibility of producing short runs of products, according to individual orders.

In the plywood industry, there is also information flow relating to changes in technological processes with a view to optimizing them. The exchange of such information is at trade fairs, conferences, through professional journals, associations, and through collaboration with research institutions of the wood sector.

The observation of Polish plywood industry shows that the significant majority of plants use the same input vector factors. Differences in their activities, which are based on the proportions of the final and secondary products, have their origins in the processing phase. The next stage of this work is to analyze the potential modification of selected steps of the plywood production. This will show the optimization of plywood production, based on modifications of the initial stage – veneer manufacturing. Table 1 and Table 2 show the possible options.

Table 1
Present operations of veneer production (own research).

Operation	Actually applied	Disadvantage	Advantage
Raw material' store	Store in a landfill yards	Pre-drying, spraying necessity, significantly large surface	Easy access when manipulate
Manipulation	Transversal saw blade	Limited diameter of the processed log	Limited manual labor
Debarking	Before hydro-thermal processing	In case of some wood species the cracks occur	Hydrothermal processing shortening, no pools' contamination, no wood discoloration
Hydro-thermal processing	Boiling	Water consumption, necessity to clearing and replacing	Soft plastification process, easy to control
Peeling	Spindle peeling machine	Worse use of raw material	Less complicated construction
Raw material' store	Store in a landfill yards	Pre-drying, spraying necessity, significantly large surface	Easy access when manipulate

Table 2
Potential operations of veneer production (own research).

Operation	Potential	Disadvantage	Advantage
Raw material' store	Water or water-landfill yards	Necessity to remove from water for Winter, access to the water reservoir, complicated manipulation	Better quality of raw material, the possibility of long-time store without quality decrease, simple infrastructure
Manipulation	Chainsaw	Manual service, process conducted directly on the yard	Flexibility
Debarking	After hydro-thermal processing	Hydrothermal processing elongation, pools' contamination, wood discoloration, elongation of the time from the hydrothermal processing to pilling	Easier debarking and smaller damage of the valuable wood zone, longer work time of the debarking machines
Hydro-thermal processing	Brewing or brewing with the water pad	Intensive process, hard to control, complicated equipment	Possible to realize in chambers, lower amount of sewages
Peeling	Spindleless peeling machine	More complicated construction and use, high cost effectiveness	Better use of raw material, higher efficiency
Raw material' store	Water or water-landfill yards	Necessity to remove from water for Winter, access to the water reservoir, complicated manipulation	Better quality of raw material, the possibility of long-time store without quality decrease, simple infrastructure

In the first step, which contains storage of raw material, it is possible to use water or water-landfill yards. Despite the disadvantages connected with the need to remove the raw material from water in winter, access to the shoreline of water body and complicated manipulation, the raw material stored in this way is of high quality and there is a possibility of long-term storage without quality decrease. This type of storage opens the possibility of flexible management of raw material supply.

Currently used material handling operation, which entails its division with the use of a transverse saw blade, seems optimal. The limited human input factor is an advantage. At the step of manipulation, the preliminary sorting of raw materials occurs. The alternative can be manipulated directly on the yard of the raw material using mobile chain saws. This enables a more favorable manipulation while sorting. This avoids the intermediate storage of the raw material with current demand, which simplifies the step of the manufacturing process.

At the next step, before hydrothermal treatment, raw material is subjected to debarking. Debarking after the hydrothermal treatment is carried out with less effort, and the results of the operation are more satisfying. However, most of the factories prefer debarking prior to hydrothermal treatment. It has been shown that such a sequence reduces processing time, pools' pollution and the color changes in wood are subtler and less frequent. The above-mentioned hydrothermal treatment is carried out in hot water. This process can be realized under mild conditions, which provides high quality of the material. The main disadvantage of that solution is the need for water purification. An alternative for hot water treatment is steaming. It leads to time savings, but the

main problem might be reduced quality of the product, difficult process control and insufficient plasticizing of wood. The advantage of steaming is a limited amount of generated waste and the option for the process to be performed in chambers, so that boiling pits are not necessary. Veneers are subjected to rotary cutting. An alternation in this operation is using a new type of peeling machine, which primarily increases material efficiency and improves the quality of the obtained veneers. This solution is characterized by a higher degree of complexity of the machine.

The end of the production cycle of the company will generate the following output:

- finished goods from basic production in the form of plywood and its products,
- side production: elements of fencing, wood chips, firewood, heat, waste,
- capital plus profit from the sales of finished goods and side production,
- waste (sizing, non-wood materials, contaminated water, container, used lubricants and oils, municipal),
- information (technical costs of the production, customer feedback, cost information).

The company selected for the analysis, over the last few years, has made many changes and upgrades allowing for a broad consideration of all aspects of the production system model. The modern lines allow for a better use of raw materials while reducing waste and expanding the number of varieties of finished products. Attention should also be paid to the output vector which, thanks to modern technology, reduces the amount of waste such as sizing and have a positive effect on the cost policy of the company.

However, most of the plywood plants operating on the Polish market are characterized by older technology that is not enough to achieve both greater efficiency and effectiveness. Obsolete machine parks also cause increases in waste suitable only for fuel and not for further treatment and sales. An important aspect of the production system model that distinguishes technologically weaker plants is the increased total production cost. Its growth will be largely affected by the use of employees – not modern machinery and equipment.

In the model, in addition to elements of vector input and output, management plays a key role. Depending on the nature of production, it may cover different areas. The plywood plant has been identified in the following management features:

- trading of raw materials,
- purchase of additional materials,
- research and development (in plants with poor automation level, research and development is conducted on a limited basis due to lack of both – the means to conduct the research and the possibility of future implementation),
- distribution,
- marketing,
- financial management,
- quality, human resources and sustainable development policy.

Also in this case, you may notice great differences between plants with modern production lines and those using the old production system. The personnel policy, the same expenditure on staff development and training will be reduced in automated factories, due to reduced employment. Such companies usually increase the costs associated with the quality policy in order to attract as many customers as possible.

These steps are part of a typical management model which manufacturing companies use. Divided powers often lead to inconsistencies in the plant policy, which could translate into risks associated with inadequacy of demand for materials needed for production or incoherent policy, distribution and marketing of finished products.

Therefore, it is worth paying attention to the new approach to management, which is the policy of sustainable development that is adapting such management of natural resources as to meet the social needs of both current and future generations, harmoniously combining the care of cultural heritage, combined with the progress of civilization and different economic groups. The use of the cited strategy helps to improve competitive position, the image in the eyes of potential customers and to reduce environmental conflicts.

Partial use of such management strategies can be seen in the described wood industry plants.

An important aspect contributing to changes in the enterprise is the role of post-production waste. The possibility of waste recycling will reduce the cost of disposal, resulting in its development as an alternative fuel used for technological purposes. Introduction of effective water recirculation system used for irrigation of wood in the landfill gas will contribute to costs reduction.

New technologies allow for positive changes in the companies in a broad aspect of their business. But we must not forget that not all businesses can afford such a solution, because of the high cost of innovation. Thus, the lack of innovation policy will act as a barrier to new, more demanding markets entry.

Conclusion

Summing up the above considerations, there is a positive trend regarding changes in the investment management in plywood industry. The greatest changes can be seen in the modernization of production lines, which are designed to improve the efficiency of the production process in terms of productivity, quality and prices of finished products. It should also be pointed out that the introduction of the proposed changes directly translates into reduction of emissions of environmentally harmful factors (dust, noise, emissions of volatile organic compounds). Conducted environmental policies will improve the output vector, resulting in reduction of the elements that compose it.

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