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LOGISTICS ASPECTS OF MATERIALS FLOW IN PRODUCTION PROCESS

Summary. The aim of the article is to present the research methodology for the analysis of material flows in the manufacturing process. The methodology involves first selecting characteristics for implementation flows in the production process, which analysis allows the identification of potential sites where the stocks are in progress. Research methodology was reviewed in a case study in the chosen field of machine manufacturing company.

ANALIZA PRZEPIYWÓW MATERIAŁÓW W PROCESIE PRODUKCYJNYM W UJĘCIU LOGISTYCZNYM

Streszczenie. Celem artykułu jest przedstawienie metodyki badawczej na potrzeby analizy przepływów materiałowych w procesie produkcyjnym. Metodyka w pierwszej kolejności obejmuje wyodrębnienie cech charakterystycznych dla realizacji przepływów w procesie produkcyjnym, których analiza pozwala na wyodrębnienie potencjalnych miejsc występowania zapasów produkcji w toku. Metodyka badawcza została zweryfikowana w ramach studium przypadku w wybranym przedsiębiorstwie produkcyjnym branży maszynowej.

1. Introduction

Logistics in production deals with the organization of the production system and its nearest surroundings warehouse and transport. Thus¹, the subject of logistics in the production are:

¹ Bendkowski J.: Practical aspects of logistics in production. Unpublished.

1. Planning, organizing and controlling the flow of raw materials, components and intermediates during production,
2. Material flows through:
 - Supply storages,
 - Indirect storages – sockets, positions, faculties,
 - Finished products storages.

It is known that the processes of movement and storage are accompanied by streams of information, which primary objective is to enable control of these flows. One of the areas of business including production logistics issues are inventories of raw materials and intermediates required for the implementation of production processes in the company.

Economic changes, which were followed in recent years indicate an increasing trend to reduce supplies in industrial companies. However, despite the diametrically improvement in the area of supply, many companies still remained high material supplies forced uncertainty as to the needs of production, or rather unpredictable demand for the products. Despite the variety of organizational solutions, application of increasingly sophisticated information systems that support flows of materials, still too high of stocks is one of the fundamental problems faced by contemporaries managers. Store is an example of a conflict resulting from the ratio between the size of the backlog, customer service levels and costs associated with its maintenance. The greater level of uplift, the higher level of customer service but at the same time higher costs of its maintenance. Therefore, the dispute settlement skills are necessary for the proper functioning of the enterprise on the market today. The diversity of modern systems, methods and approaches to control inventory makes this issue is closely linked with other areas of business management, thus creating one controlled complex “organism”. Many methods of inventory flow control requires close integration, or individual cells, the production departments, or downstream in the supply chain. The aim of the article is developing the methodology for analysis of materials, with identifying the inventory places, to determine their structure and generated by costs above the selected manufacturing process.

2. Research methodology

Material flows in production processes are multidimensional. The conditions of these flows are affected by factors that can be included in the following groups:

- *technical and technological factors*, taking into account the methods and techniques of manufacture, the technical level of production equipment,
- *organizational factors*, including primarily the management and organization, types, forms and varieties of the manufacturing process, material and information flows,

- *economic factors* that are associated primarily with the measurement of performance by the company using the performance metrics, utilization, productivity and efficiency,
- *social factors*, which are related to personnel participating in the implementation of the manufacturing process.

The proposed research methodology in the examination of material flows in the manufacturing process used for concept consisting of a sequence of steps. In the first stage of this study was to identify the specific object under badAnia by specifying certain characteristics of the object (important for the investigator and relevant to the research). The next steps are to transform the system - building on the overall picture of the formation and identification of constraints places formation associated with the implementation of the flow in the production process, using the method: the process mapping, the Big Picture analysis with the companies documentation analysis.

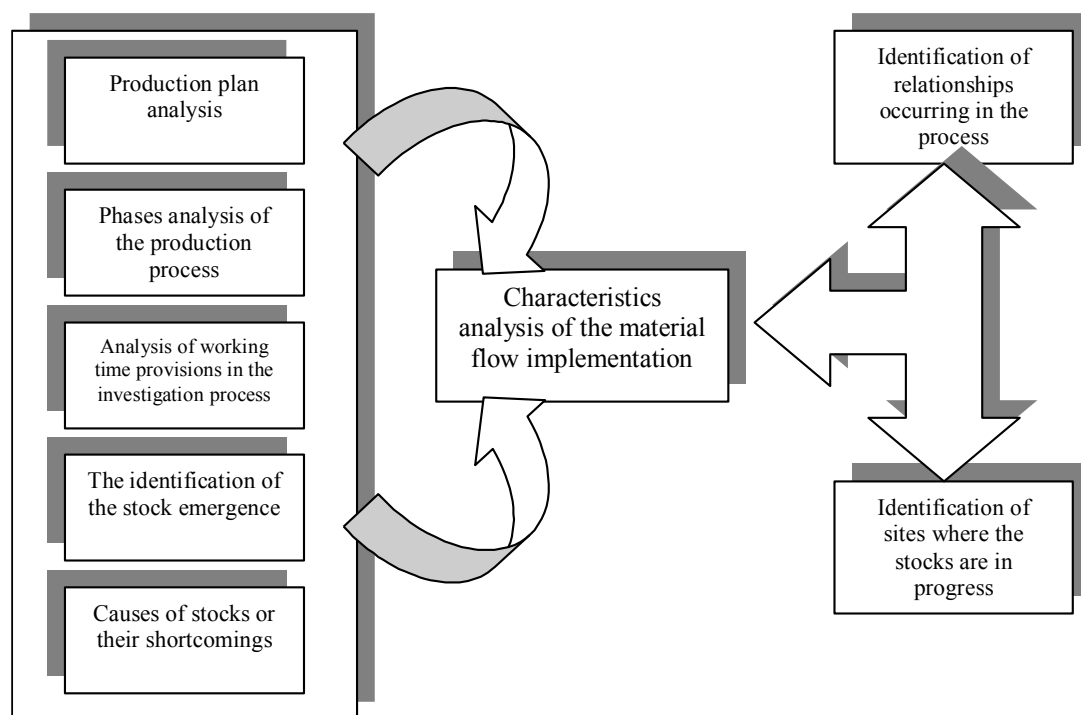


Fig. 1. Researches process methodology of production process flows

Rys. 1. Metodyka badawcza przy badaniu przepływów w procesie produkcyjnym

3. Characteristics analysis of material flow implementation in production process

Studies in the enterprise for data collection, or a shortage of stocks, require an analysis of the existing situation. The main subject of study in the article is the Department of Production, comprising the Faculty Assembly, Mechanical Faculty and Magazines Group. Analysis of the processes of both departments and the stores will issue a preliminary determination on the part of practice.

Examined company exists on the market for many years. Although the trend in the contemporary economy shows a marked decrease in the quantity of the stocks, and eliminating the storage area, the company furthers has in store over stocks of materials and finished products², the level is set on the basis of any inventory control system. The main direction has recently changed the approach of management and organization of the company, through the gradual implementation of the concept of Lean Management³, which so far is the result of the implementation the principle rules of 5S⁴.

3.1. Explanation of the production plan in terms of material flows

Analysis of the production plan in terms of material flows was carried out in production company, specializing in the production of centrifugal pumps, which are applicable in particular in the energy industry, heating, the mining of zinc, salt, coal and brown coal and other raw materials and metallurgy. Analyzed the production plan gives an overview as to the quantities and types of products produced in the period considered.

In the examined company a production plan is created in the Office of Production Preparation by independent expert of the production planning. Creation of a new settlement plan is accompanied by the previous billing period. Employee of the this Office deleted from the created plan those lines which are already done and implemented the production lines based on new contracts or agreements with customers and new orders received from a prototype implementation of the leading constructor, creates a production plan for a month following available.

Order production included in the plan ends when all activities are carried out relating to the manufacture of the device and associated with the settlement between counterparties.

The production plan consisted of five parts:

² Kisperska-Moroń D.: Logistics System of Polish Economy. Karol Adamiecki University of Economics in Katowice, Katowice 1996, p. 66.

³ Origins of Lean Management is related to the production system used in the Japanese Toyota Company.

⁴ One of the elements of the Lean concept, referring to the five Japanese words that describe the standardization of maintaining order in the workplace.

1. Production plan of final products,
2. Production plan of parts for submersible pumps,
3. Production plan of parts for pumps fixed,
4. Production plan of the aggregate supply,
5. Production plan of services.

The company's production plan in the initial period of research assumed to produce:

1. submersible pumps in the amount of 193 units,
2. fixed number of pumps in 31 pieces,
3. aggregates supply in quantity 2 pieces,
4. framework for installation of pumps in the quantity of 8 units.

In addition, the plan included the creation of a number of parts, components and assemblies, ordered by a specific customer or executed in the storage⁵.

3.2. Storage of materials in different phases of the manufacturing process

Warehouses in the examined company compensate for the temporary provisions implemented on various production departments including the Department of Foundry. Waiting for the production of goods or their deficiency is associated with different categories and costs.

The company has 4 stores, which collected the material, or parts and components at various stages of the manufacturing process:

1. Sales magazine - these are the parts and components purchased in warehouses,
2. Casts magazine - gathered here casts from foundry,
3. Steel magazine - stored material purchased in the mills and warehouses (drawn bars, sheet metal etc.),
4. Finished goods magazine - collects the finished products.

The whole production process is divided into phases, which will use the materials, parts and components, taken from the respective magazines. These phases in terms of collection and storage of materials for storage is shown in Figure 1.

⁵ Products for the store are described as “saleable”, which means that there are the speculated of a quick sale.

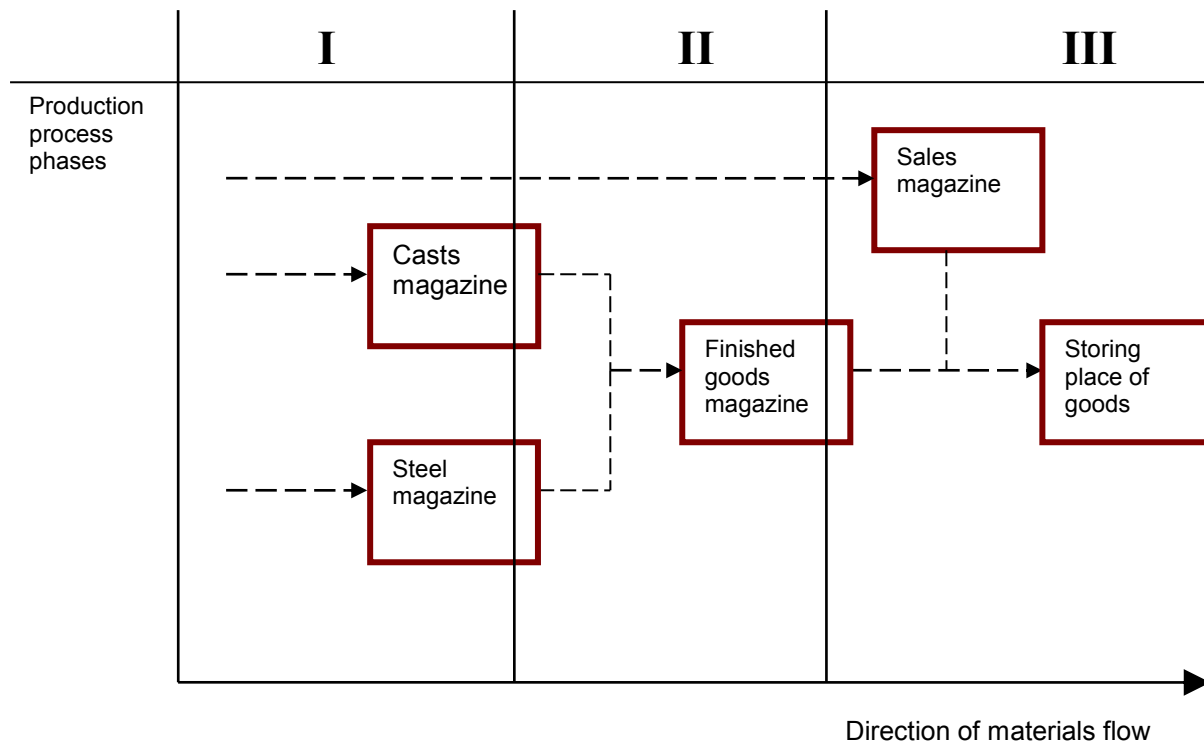


Fig. 2. The phases of production process in terms of drawing and storing materials in warehouses

Rys. 2. Fazy procesu produkcyjnego z punktu widzenia poboru i składowania materiałów na magazynach

Source: develop their own on the basis of [5]

Storage of materials found in the following phases of the production process:

I. **Implementation of a casting element** at the Department of Foundry, and placing it in the warehouse and the delivery of the finished casting material to the warehouse and metallurgical products in timee needs - store mall.

II. **Consumption item in the warehouse or cast steel products**, working at the Department of Mechanical and placing it in the warehouse of finished products.

III. **Consumption items from store of steel products and sales magazines**, assembling a finished product at the Faculty Assembly and putting it in storing place, where will be delivered to the customer.

The presented scheme provides a picture of the materials flow in the production process by individual stores. Waiting time as described in storage material for further processing depends on the type of product and for standard product is defined in the further part of the article (Figure 2). The ideal situation would be the time zero (the omission of intermediate storage), who first implied by the lack of downtime in a production cycle of products (no stocks) and, secondly, reducing customer service time, and therefore the production cycle.

3.3. Analysis of the reserves until the processes carried out at the Faculty Assembly and Faculty of Mechanical Engineering in the examined company

The study showed that the investigated company faces the problem of uneven distribution of work and its coordination with other ongoing processes between the various production departments. This is best illustrated situation in which the company manufactures finished product as a complete, ready-to-use product. Proper coordination between departments should be realized in such a way that all the necessary elements for the device and components hit the stores, or working positions when the need for further operations, or even enters the store, and once for another office. Such measures would result led to a significant shortening and the execution time of the production process and streamline the production volume of stocks during the process that cause or do not cause downtime in production due to their absence.

In practice, however, the time reserve reveal themselves through too late or too early to provide specific components and assemblies to finished goods for storage or work stations. The vast majority of components arises on mechanics department. Processing is performed on different machines by different workers, according to the workshop guides (Card Technology). Next to each operation contained in the Guide appear workshop times: preparatory and ending time (TPz) and unit time (tj), informing the operator how long the operation should continue. The sum of all times of technological operations in the Guide gives the time required to implement all of the elements. It is necessary to planning and coordinating works inside faculties and should be monitored in order to coordinate the work outside the faculties. But in order to effectively coordinate the work of the departments it should be eliminated (or monitor) work-stoppages that prolong the process of goods manufacturing and cause the accumulation of inventories in progress. The consequences are much more far reaching, because the duration of the production process affects the prices of products and the overall customer service time, which in turn affects their satisfaction and company reputation. Relationship between the various activities and processes undertaken in the company are undeniable. Inadequate functioning of some element it brings further significant problems.

3.4. Identification and analysis of the stockbuilding positions

From the standpoint of production processes carried out in examined production company stocks are stored in warehouses:

- **finished goods magazine** - there goes the elements worked in the manufacturing process at the department of mechanical engineering. These are the parts for further assembly or for sale;

- **sales magazine** - these are parts and components, which are the subject of cooperation with selected partners. Inventories are stored in the warehouse primarily due to the belief the company with lower cost of inventory, increased connected with price discounts for purchasing larger batches of materials;
- **casts magazine** - stores here products made by the foundry. Often, foundry casting carries more than is required in the contracts. This is due to material savings policy in the company. Furnaces, which do have some limitations casts, among other things, the minimum amount of feedstock needed for the correctness of their operation. Typically, it exceeds the needs demand a subsidiary company, hence, abs not to waste the surplus material are cast larger quantities of an item that goes into the store;
- **steel magazine** - there are metallurgical material for the manufacture of various products. It is the largest magazine and its action policy is similar to a sales magazine. Stocks deposited here are the results of minimizing the purchase costs, as well as inventory in progress collected directly at the working positions.

3.5. Causes or lack of supplies

The analysis of the production process in the examined company allowed to determine the structure of the stocks held by the company. It was estimated that in the sphere of physical supply is collected in about 55% of all stocks, in the sphere of production - 13%, while in the field of physical distribution of approximately 32% stocks. Studies have shown that the causes of excessive accumulation or lack of inventory are the following factors:

1. Uneven activities arrangement between production segments.
2. Inadequate organization of parts and goods supply processes.
3. Inadequate organization of the production system
4. Lack of control over work stoppages, due to lack of materials to production process.
5. Failure to meet deadlines for product.
6. Inappropriate timing of delivery of materials by the suppliers.
7. Production shortages
8. No using of controlling inventories methods.

Research has shown that the company does not maintain a regular stock in the form of security, a minimum, the orders. This means that there is a need to control their level. All material contracts executed are "constantly". This is due, inter alia, with easy access to many materials which can be delivered in a very short time, concerns include commercial and metallurgical materials.

4. Relationship identification between production cells in the examined company

In order to determine the relationship between the cells in the company it was used the relationship map, which illustrates the main entities involved in business process and their interrelationship in the form of materials, information and money flows⁶.

Figure 2 illustrates how lopsided is a block of stores by the bands flow. The analysis showed that magazines play an important role in the functioning of the company⁷.

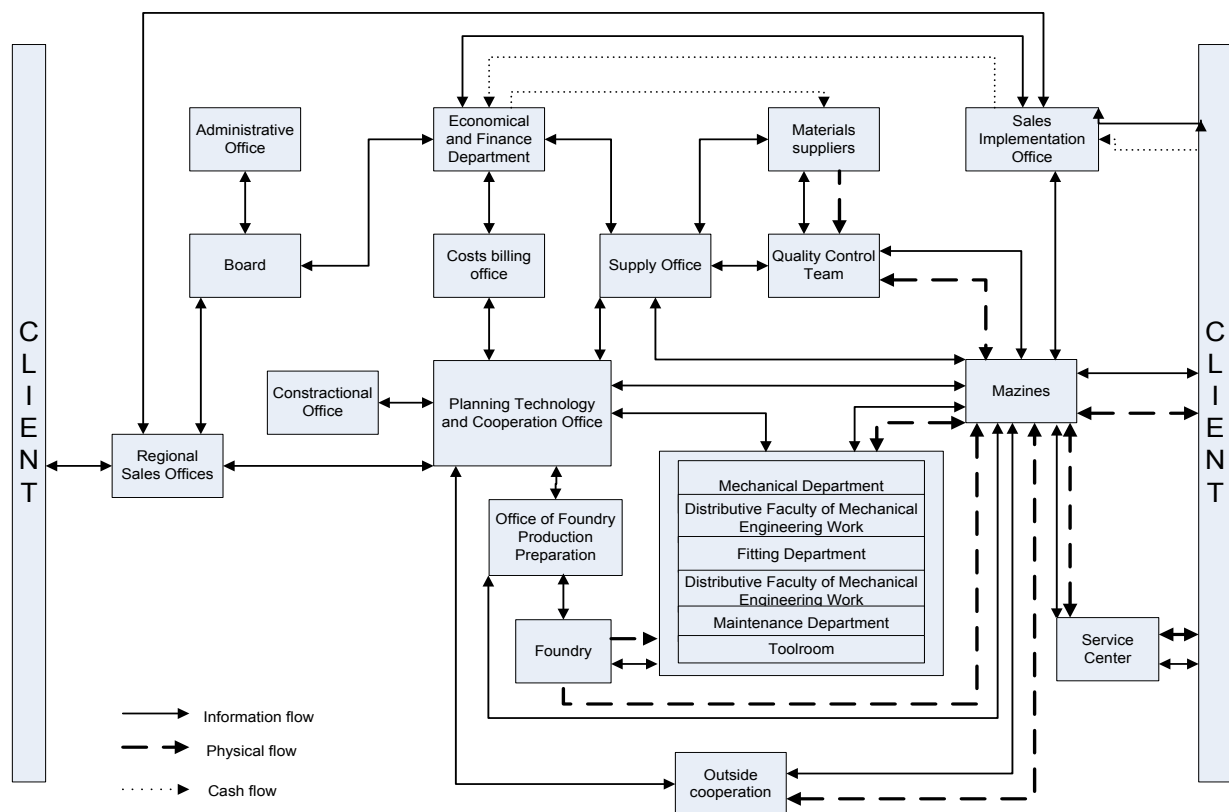


Fig. 3. The map of relation in Researches Company

Rys. 3. Mapa relacji badanego przedsiębiorstwa

Source: develop their own on the basis of [5]

⁶ Bozarth C., Handfield R.B.: Introduction to operations management and supply chain. ONE Press, 2007, p. 84.

⁷ In fact, this is contrary to the policy pursued by the examined company for non-production stocks control level.

5. Materials flow in production process

In the examined company the production process is not planned so as to minimize the actions involving the movement of materials. Document that indicates the sequence of individual processing elements and machinery and equipment involving in the production process is a workshop guide (Card Technology). For a detailed analysis it was selected the production process of the sleeve spacers, mounted in a standard product of the company and presented it in the form of the process maps (Fig. 3 to 7). Production process map of the standard device shows the individual steps necessary to achieve the finished product and the position of production on which these acts are performed. Particular attention was given to downtime of material between workstations.

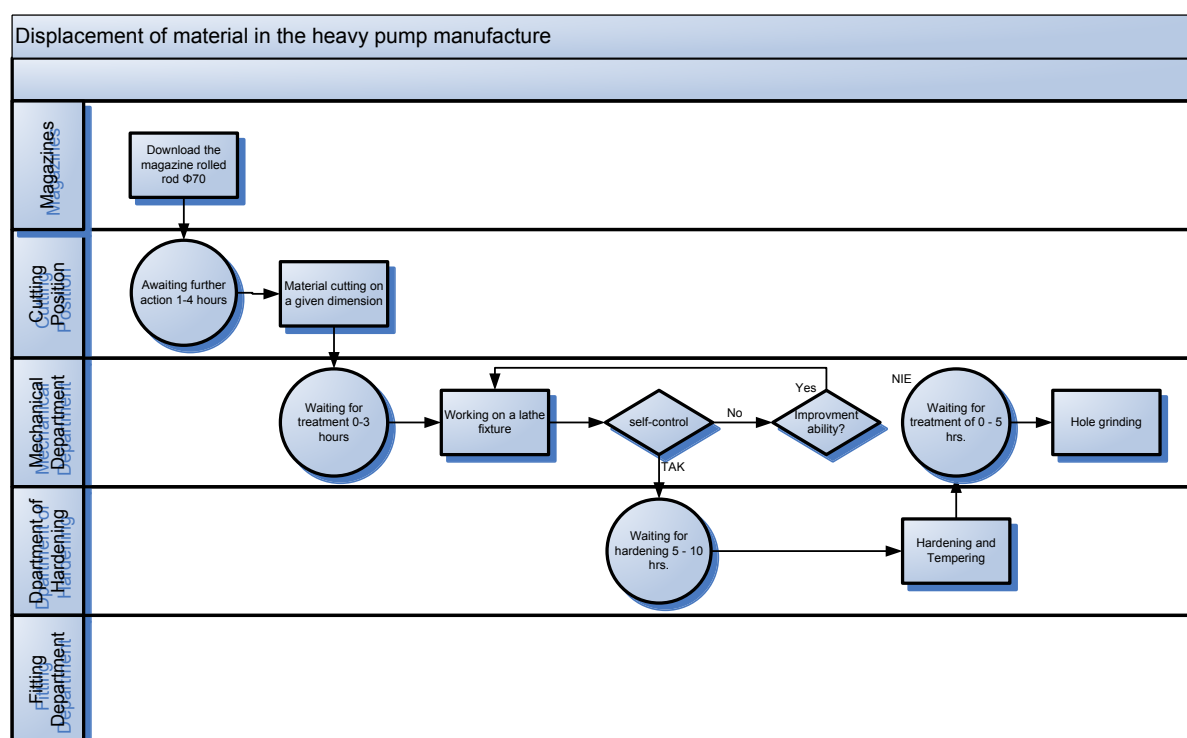


Fig. 4. The process map of materials flow in production process (1)

Rys. 4. Mapa procesu przepływu materiału w wybranym procesie produkcyjnym (1)

Source: develop their own on the basis of [5]

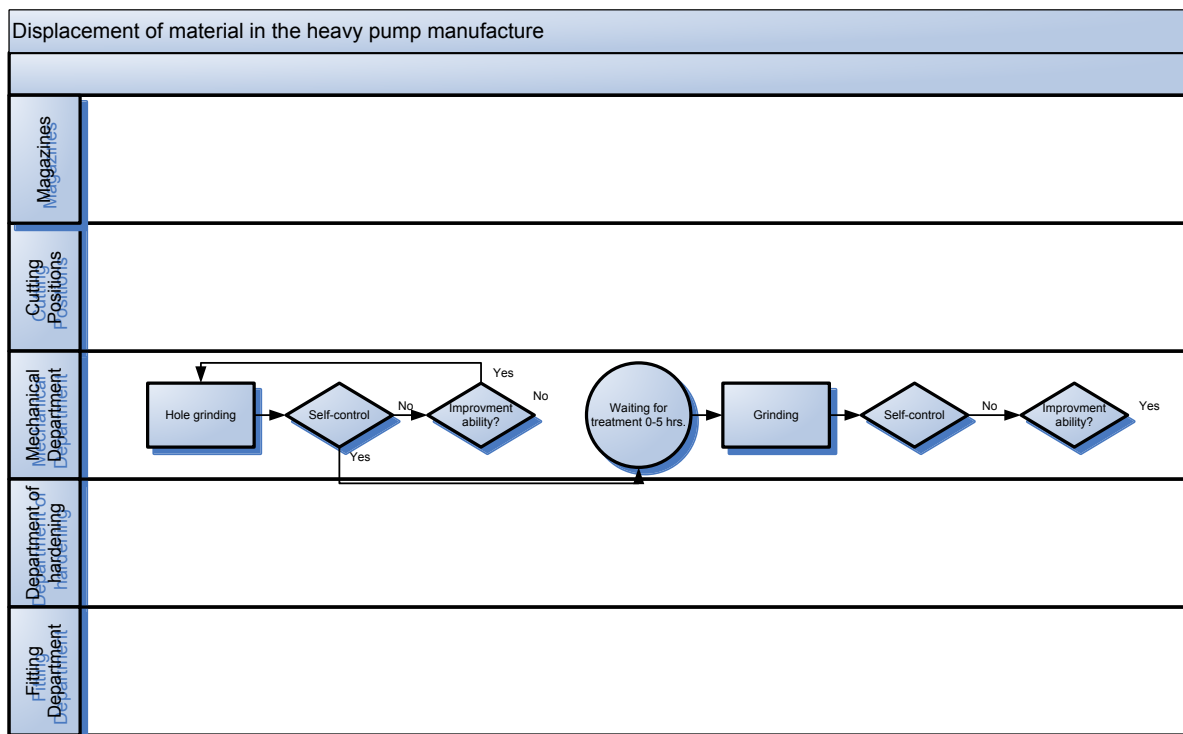


Fig. 5. The process map of materials flow in production process (2)

Rys. 5. Mapa procesu przepływu materiału w wybranym procesie produkcyjnym (2)

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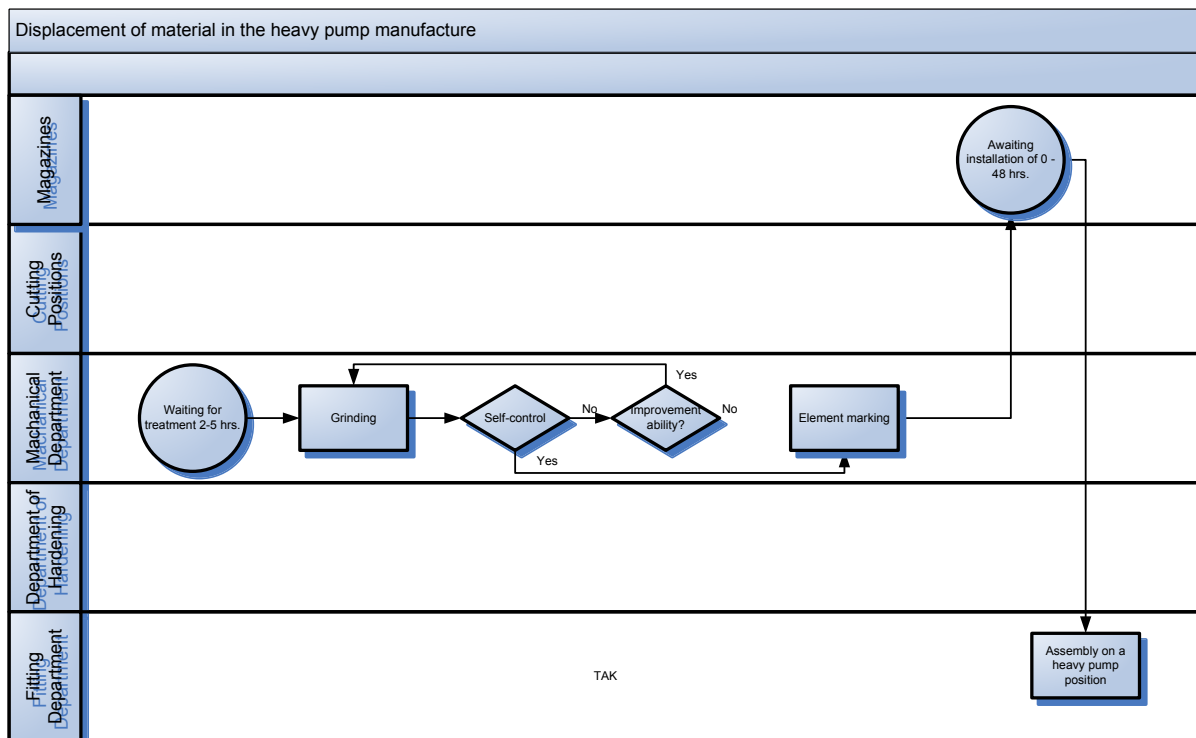


Fig. 6. The process map of materials flow in production process (3)

Rys. 6. Mapa procesu przepływu materiału w wybranym procesie produkcyjnym (3)

Source: develop their own on the basis of [5]

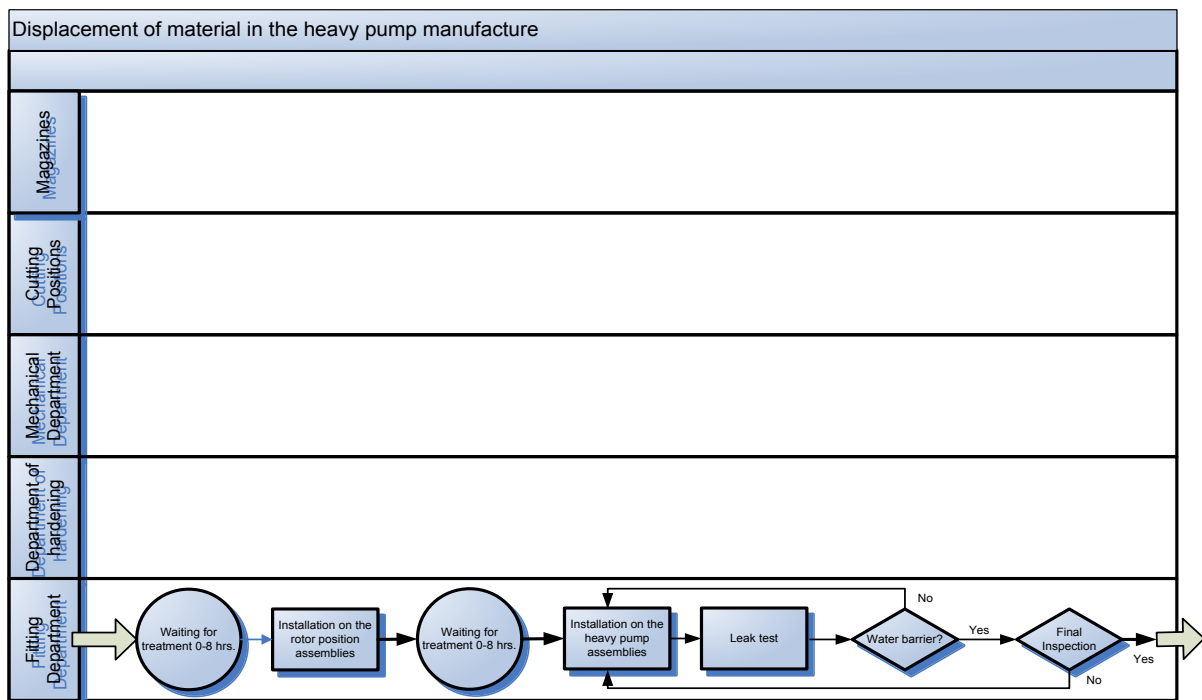


Fig. 7. The process map of materials flow in production process (4)

Rys. 7. Mapa procesu przepływu materiału w wybranym procesie produkcyjnym (4)

Source: develop their own on the basis of [5]

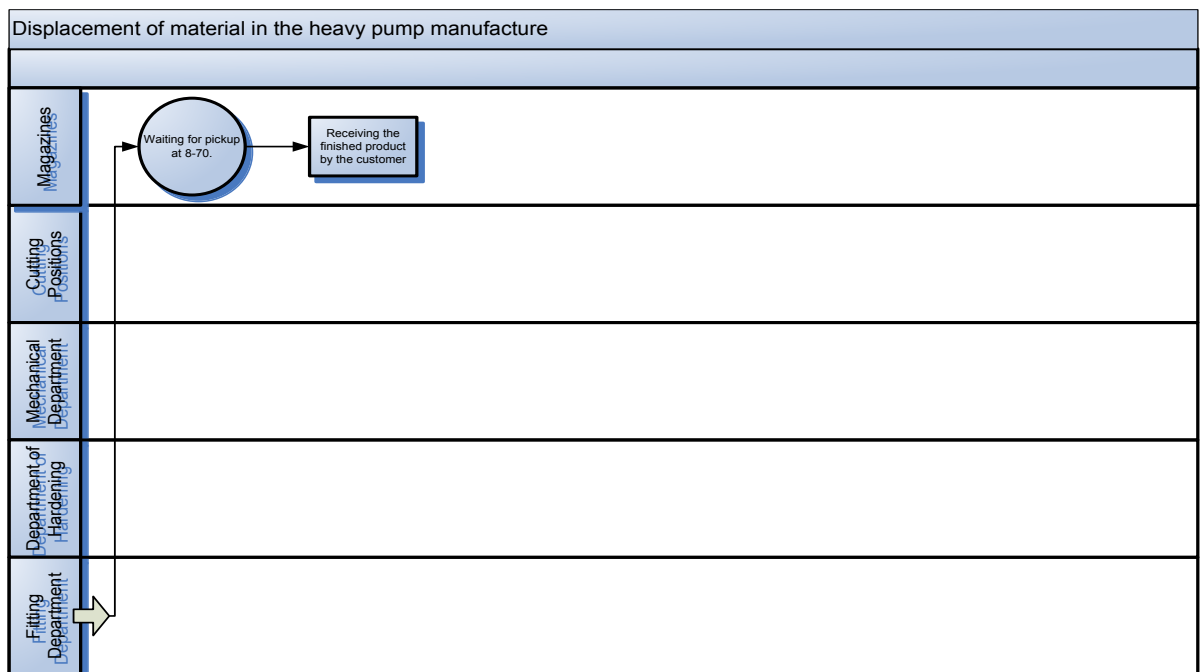


Fig. 8. The process map of materials flow in production process (5)

Rys. 8. Mapa procesu przepływu materiału w wybranym procesie produkcyjnym (5)

Source: develop their own on the basis of [5]

6. The location of inventory in progress

The location of inventory in progress is refer to the Faculty Assembly of the enterprise. The Faculty has eight workstations, dealing with various assembly processes. On the basis of the production process map and research conducted at the Department, identified the places of excessive inventory in progress, namely:

- heavy pump assembly position,
- rotor assemblies position,
- light pump assembly position.

In the company has identified both intracellular and intercellular stocks in progress. It was also found the presence of downtime due to lack of interop components for the goods production. The production cycle length of the standard product is approximated about 19 days. This period also includes the downtime material during the manufacturing process, resulting in the formation of stocks and work-stoppage during production process.

On the process maps it was included the time intervals of material expectations for further processing, for various reasons. Aggregating the value of the minimum and maximum downtime of material in the production process it was specified maximum and the minimum sum value of waiting for treatment. The maximum period of downtime in the manufacturing process is 78 hours (12 days and 6 hours.), a minimum period is about 8 hours.

7. Conclusions

1. The proposed research methodology in the article is an attempt to respond to determine the type and availability of information to study the flows in the production process and the occurrence of stock-in-progress, which is one of the most important logistics problems in manufacturing.
2. The proposed methodology of the research does not exhaust the scope of such information, but for the purposes of identifying the type and distribution of the stock-in-progress, as demonstrated by research, is sufficient.
3. Researches company does not use any inventory control system. In stores and between the production positions accumulates unplanned stocks, which extend the production cycle and generate costs. Nor adversely affects only for the functioning of the production sphere, but also the overall operation of the business.
4. The analysis showed that it is necessary to implement certain improvements to allow for a reduction to the minimum value of the final products, which will, inter alia, to shorten the execution time and eliminate stocks work in progress, thereby reducing the cost of the firm.

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