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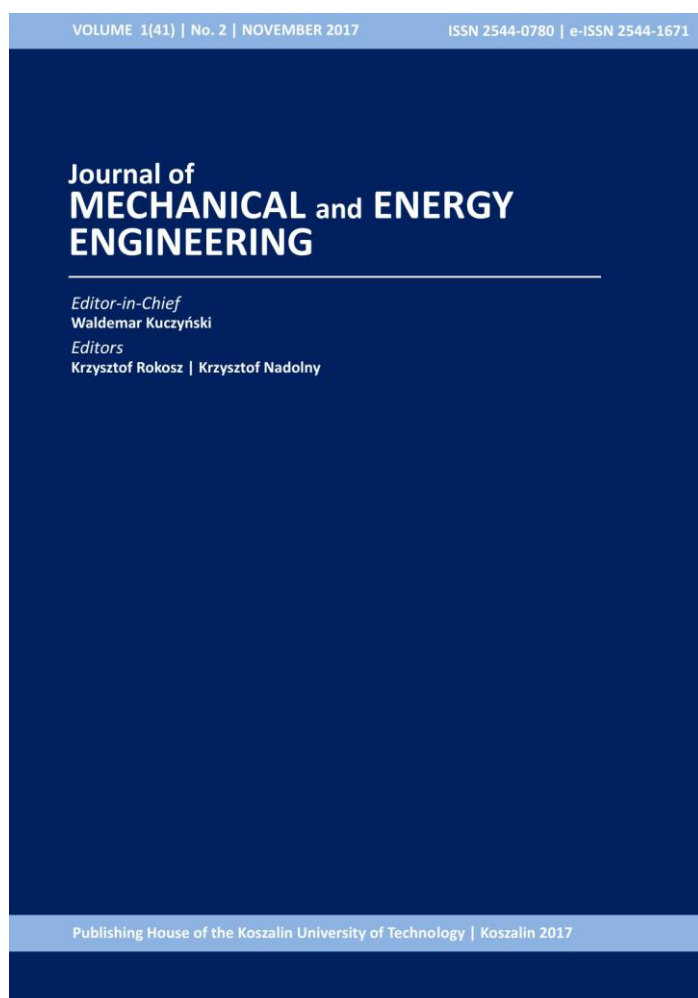
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# VALUE STREAM MAPPING OF THE PRODUCTION PROCESS OF TANKERS FOR THE TRANSPORT OF LIQUID FOOD PRODUCTS

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**Abstract:** The article presents an example of the value stream mapping method application for the analysis of the production process of semi-trailers for transporting liquid food products. Below were presented characteristics of value stream mapping method, construction, functions and course of the trailer production process in details. On the basis of value stream map analysis conclusions were drawn that point out possibilities of improving and reducing the production costs of tankers for liquid food products transport.

**Keywords:** value stream mapping, production process, tanker, efficiency analysis

## 1. INTRODUCTION

Large production plants often have to cope with too long production cycle time for a given product. In a rapidly changing world, companies should anticipate risks in good time and identify opportunities for exploitation. The production of complex industrial products requires the use of a sequence of technological operations performed in a specified order. The time consuming nature of a production depends on the complexity of the product, quantity of components and the number of employees involved in the operation. Maximizing productivity depends mainly on the methods chosen to analyse current problems. Overcoming production errors by management and anticipating what may be needed in the near and distant future is essential for the proper functioning of the company. *Technological foresight* and *value stream mapping* are excellent research methods in this area. Foresight combines routine management actions with prediction of technology, which can be used in the future so that subsequent production stages can be performed faster and cheaper. This method is considered to be future-proof and very necessary in large companies [1]. The value stream mapping is characterised by two application areas. The first is to

make a diagnosis, which should be used in specified conditions. The second is the use of a quality development to control the value stream analysis. The evolution of the quality function is very successful in production and service processes [2].

## 2. CHARACTERISTIC OF THE VALUE STREAM MAPPING METHOD

Value stream mapping improves the flow of value added in a company. It is used in both production and service companies. It is often referred to as drawing a block diagram illustrating, analyzing and improving activities to deliver a product or service. By mapping the value stream, it's possible to cut the product's transition time through the process and increase the ability to respond to customer demand [3].

This type of mapping dates back to 1918, when Charles E. Knoepfel included examples of diagrams showing the flow of materials and information in his publication *Installing efficiency methods*. Over time, this type of information display was identified with the Toyota production system. The creation of this system is attributed to four member: Shiego Shingo (Japan's engineer) and directors of Taiichi Ohno, Kiichiro Toyoda, Eiji Toyoda. Until the 1990s, when lean production methods were spreading in the United

States and around the world, the value stream mapping became increasingly common. Value stream mapping was also used in *six sigma* methodology. The method aims to eliminate waste and create the most efficient system. Using the above method, it is worth focusing on process changes leading to waste. Mapping a stream of values, just like other visualizations, serves as an effective tool for communication, collaboration and even changing the work culture. Decision-makers can clearly visualize the current state of the process and where waste is generated. Problems such as delays in the process, excessive downtime, constraints and stock problems can also be seen [4].

The effectiveness of value stream mapping depends on simultaneous mapping of the material flow and the linked information. This is also due to the fact that this method allows to see all process from client perspective. It allows to present, usually in graphic form, all activities and connections in the organization. Value streams are therefore all the activities: adding value (freedom and flows) and not adding values (disturbances) in all stages of the process through which a product passes from placing an order by the customer to its realization and delivery of the finished product. As a rule, disturbances that affect the balance of the process are examined. The mapping not only allows to identify disturbances in the stream and eliminate or limit them, but also get to know the process by capturing key data at each stage of the process. The created map provides a coherent picture of the whole process, and detailed close-ups for each stage.

The main purpose of value stream mapping is to identify and eliminate wastage that prolongs the so-called *value stream*. Lead time is the time of product passing through the process until it is delivered to the customer [5].

### 3. ANALYZED PRODUCTION PROCESS

The subject of analysis in this article is the process of production of tankers for liquid food products. The following is a description of the production process based on a detailed analysis of the customer's order. This is an extremely important issue when introducing the production of a given trailer. It mainly depends on the need for cargo transport equipment. Semi-trailer for the transport of liquid food products is used to transport them in large quantities at one time from the place where the load is concentrated to the manufacturer of semi-finished products. An example of a place where the load is concentrated (milk) can be a dairy, and a producer of semi-finished products – cheese or yoghurt factory. Carrying 34 000 litres of cargo (average payload of a tanker) at one time saves time and ensures freshness of the transported load. The construction of a semi-trailer means that the load is safely transported and quickly reloaded. The semi-trailer is usually made up of three chambers for This is

the optimal distribution for the above mentioned cargo. Before the trailer is manufactured, it is designed in a design office. Production documentation is created for each department of the company. Material standards are also being developed for the production preparation and procurement department. Each of these departments, after thorough analysis, gives further instructions to the relevant executive departments. One of them is a magazine that spends commercial elements and semi-finished products. After the supply department has remedied the deficiencies, the process begins. The complete material for production is transferred to the relevant units in the company.

In the first stage of the tanker production, the tank body is made. The tank compartments are made of stainless steel sheet OH18N9 cold rolled with surface 2B. In order to achieve the desired shape of the roll, the sheet is processed by machining on cylindrical presses with a specified spacing. Rings are built from suitably adapted sheets of metal, which are connected by TIG welding (*tungsten inert gas* – a method of welding with tungsten electrodes in inert gas shields such as argon or helium or their blends). They are then joined by the same welding method to form an empty cylinder in the centre, shaped by a corresponding strut. In the next step, internal and external extruded ends are inserted into the roll. The manhole openings, bottom valves and fittings are then cut out. The bottom rings are inserted after the previous work has been completed. At the same time, the preparation and fastening of frames and heating coats can be carried out on the outside of the tank. Then the valve stubs are led out through the previously shaped holes by TIG welding.

In the second stage, the tanker is prepared for the thermal insulation. To keep the insulation in place, TIG welding is used to assemble distances. In this case, the installation of distances is not necessary. Where the specification of a semi-trailer provides for its fitting with a load heating system, the heating jacket shall be poured in a further stage. Next, the weld flanges of manholes and bottom valves are welded using the TIG method. After welding the invisible fittings (armature concealed under the outer jacket and insulation), a tanker can be covered with mineral wool or polystyrene shale, previously cut out on the plotter, to ensure the required thermal insulation. The chassis on which the tank is mounted is usually supplied at this stage of felted ring (groove made by processing under the press). As shown in Fig. 1, the next step is to calibration of the capacity, advertisements sticking and cleanse. Calibration of the capacity consists in checking how much liquid, most often water, can actually be placed in a tanker and in a handling installation. If a semi-trailer meets all quality criteria, it is ready to be handed over to the recipient. If, it does not meet the requirements of quality control, the defects in the production process are rectified [6].

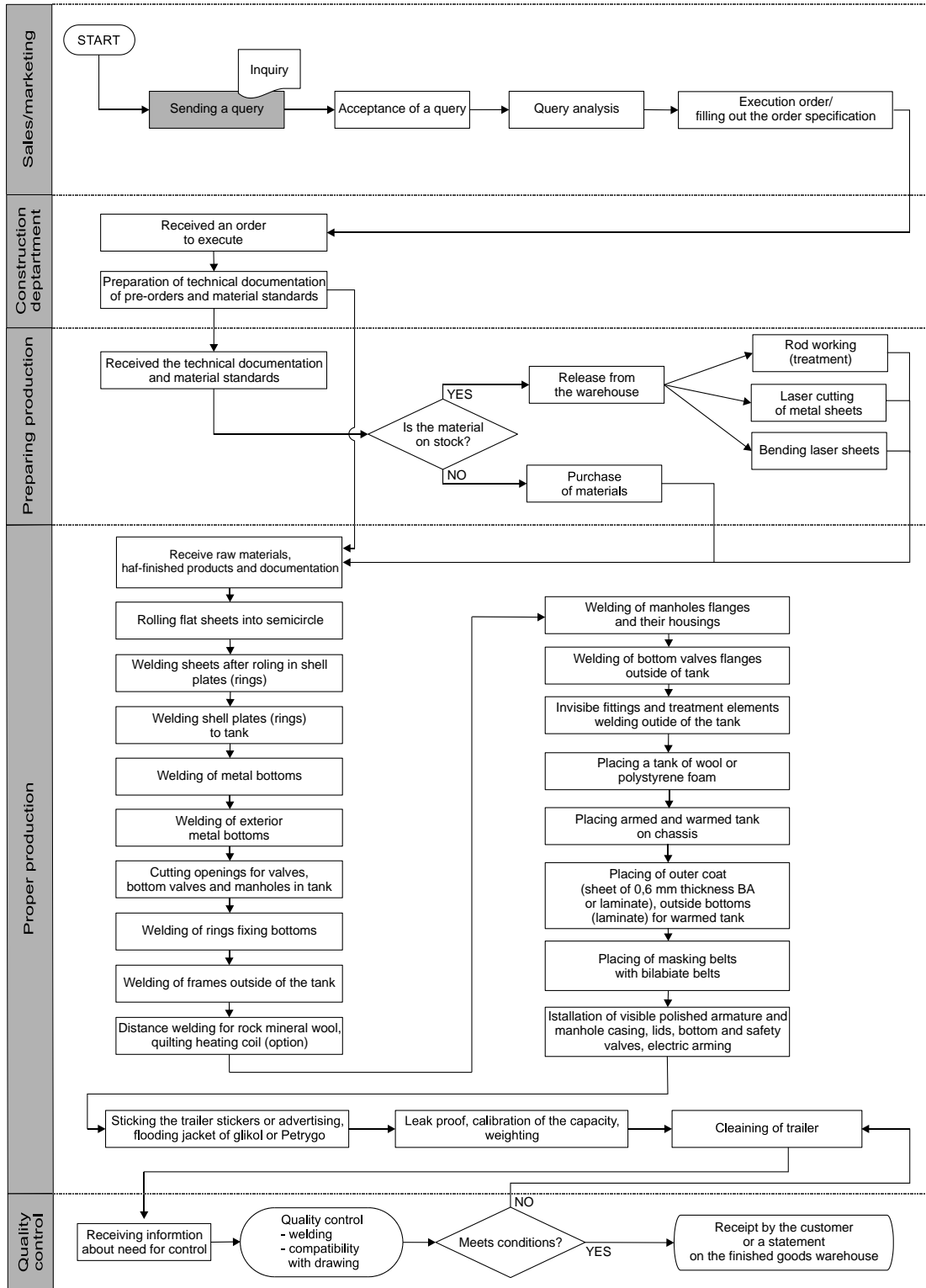


Fig. 1. Map of the production process of tankers for the transport of liquid food products

#### 4. VALUE STREAM MAPPING OF PRODUCTION PROCESS

The value stream mapping is applied to process improvement in accordance with the lean principle. In the application of this method, great emphasis is placed on process analysis in terms of the value stream including steps taken during production and delivery of the finished product to the customer. The essence of value stream mapping is shown by many specialists as providing benefits, mainly within production processes. Due to its universality, it is used in many areas, however, the most common application of the mapping method is limited to production processes and broadly understood manufacturing industry [7].

There are three stages of mapping: a map of the current state value stream, a map of the future state value stream and an action plan – planning of the transition to a lean production plan. *The first stage* shows that a specific survey object or group of objects for which the demand is highest or which generate the highest income is selected. The selection criterion is determined by passing through each operation in the process. Then the information about the present state of affairs is collected. Information such as the quantity and type of product and the time of delivery to the recipient should be included here. Cycle times, rearming, availability and number of operators are also important. Maximum productivity is also important information. It is also worth measuring the duration of the operation, analysing the organization of the position and pointing to ideas for improvements. It is necessary to provide information on the movement of the product in the process and in what form the material is ordered. The sequence of drawing the map is not random. First the customer is drawn with his requirements, then all processes with key data, inventory, product movement, information flow and then the time axis is drawn. The axis indicates the time of the product passing through the process and the times of adding value to each stage.

In the *second stage*, an optimal design is created using different types of tools such as Kanban, supermarkets or operating slots. This leads to a lean stream of values. It is a continuous flow to the greatest extent possible, without errors and downtime. Decreasing the value stream reduces the transition time.

*The third stage* is to plan the transition to a lean production system. Here the order is reversed. Start with the last process and move upstream. This is helpful when introducing the title of production without interfering with it. In the case of sudden changes, start by eliminating bottlenecks (the stage with the lowest efficiency, which limits and determines the potential of the whole system) [8].

In accordance with the action plan presented, a value stream map has been drawn for a trailer for the

transport of liquid food products. It was started with checking what the customer needs. An analysis of all the necessary elements was made, a forecast was applied and an offer was sent to the customer (marketing department). Once the conditions have been accepted, documentation is prepared. Next, the project is sent to the decision-maker. When everything meets the customer's requirements, the project is taken away from the production preparation department, where materials are prepared that were previously ordered by the procurement department. The schedule determines the order of project execution and confirms the date of completion. The product is then followed by the subsequent production steps. At the end the semi-trailer is cleaned and covered with advertisements as shown in Fig. 2. Generally, customers receive the finished product themselves, in the following case the customer was the National Fire Brigade.



Fig. 2. An example of the possibility of placing ads on the outer jacket of a milk transport tanker

With reference to the value stream map shown in Fig. 3, it is advisable to trace the material through the process. It can be easily seen that the most important element of the map is the customer. It is a prerequisite for the product to enter the process. This usually lasts from one week to one month. Week of time in the next stage is taken by the design studio to create technical documentation. This often goes hand in hand with the creation of material standards. It is extremely important that the purchasing department receives timely information on what elements are necessary to fulfil the customer's order. The availability of materials often depends on the complexity of the product. If it is a tanker with atmospheric pressure (up to 50 kPa), the materials are rather easily accessible. The problem begins when a semi-trailer is to carry dangerous cargo or under pressure above 50 kPa up to 200 kPa. In this case, special certificates are needed, which increases the production process of the component up to seven weeks. This is undoubtedly a bottleneck in the whole process, apparently independent of the trailer manufacturer. When the purchased materials, through the warehouse, have already reached the production stage, the stages described in more detail in Section 3 of this article are followed.

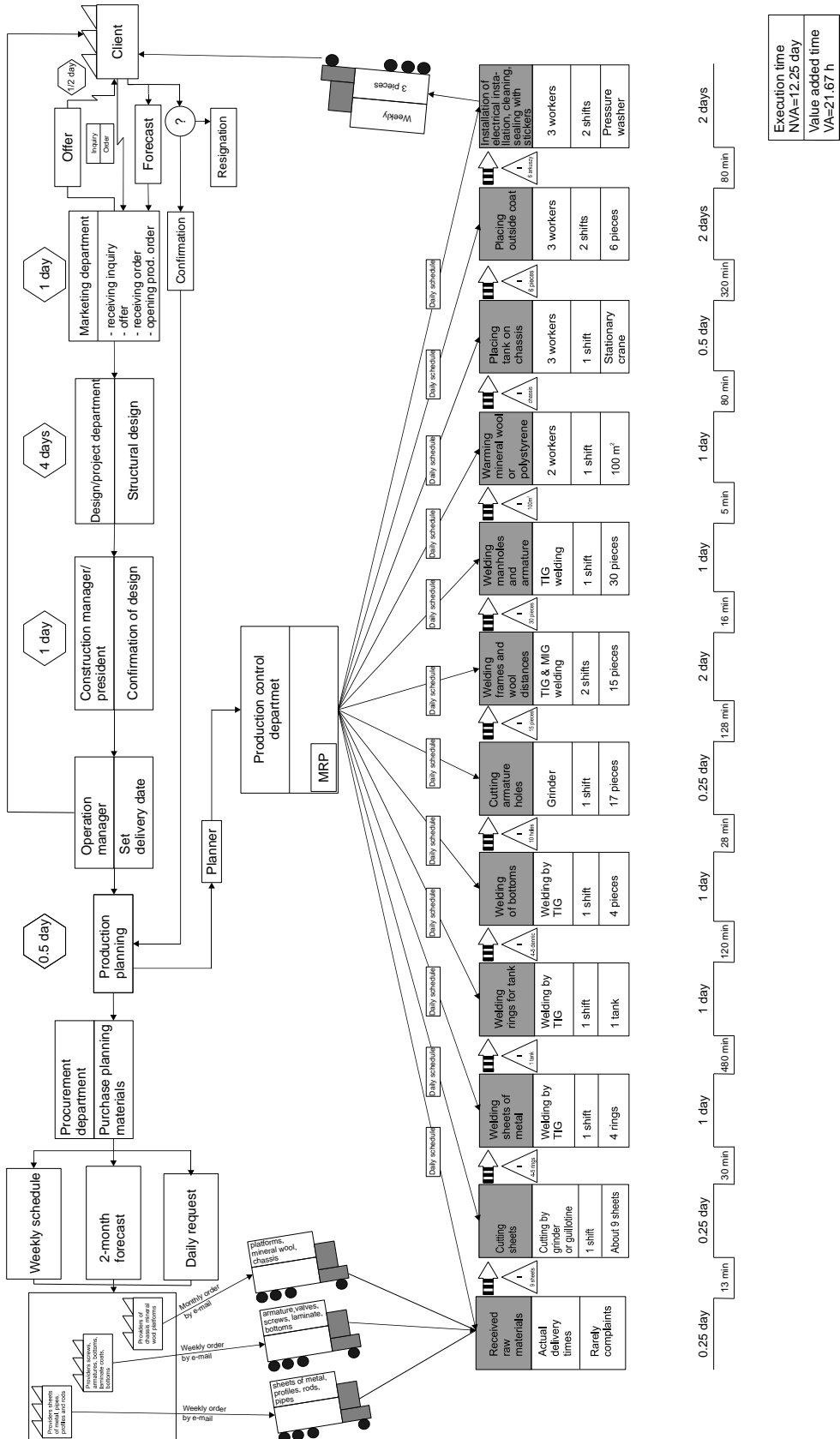


Fig. 3. Value stream map of tanker for liquid foods production process

## 5. CONCLUSIONS

Value stream mapping is one of the methods supporting activities related to the analysis of the production process. The analysis presented can be used to remove bottlenecks and improve the production quality of certain steps in the technological process. The value stream map is only the starting point for further streamlining analysis. Searching for an optimal solution to emerging problems is directed towards the method of foresight – method which is extremely useful in planning production and analysing existing processes.

The following conclusions were drawn from the analysis of the value stream mapping process for the production of tankers for liquid food products:

1. Preparing the value flow map, the existing technical documentation of the process should be taken into account (characterisation of workstations, scope of tasks and entitlements, procedures, regulations, instructions) in order to introduce changes that could accelerate the production of the product.
2. Implementation of improvements in the production process resulting from the analysis of the value stream map is aimed at reducing its costs and detecting bottlenecks.
3. It is also possible to obtain additional benefits, such as: elimination of activities that do not create added value for the product, simplification of the production and shortening the process duration.
4. On the value stream map shown in Fig. 3, it can be noticed that certain production stages can be performed simultaneously, which may shorten the time of execution of a production order.
5. The technical documentation of the basic trailer systems may be prepared before the order is received and subsequently modified for the project.

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## Biographical notes



**Marcin Romanowski** received his M.Sc. degree in Exploitation Port and Fleet (specialisation: transport) from Maritime Academy in Gdynia. He works as Logistics and Procurement Manager in PRO-WAM Company in Koszalin and simultaneously studies at second year of Ph.D at the Koszalin University of Technology. He is interested in cost minimalization and technological foresight.



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