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## Analysis of the internal door technological process

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### Abstract

Designing and proper implementation of effective processes and providing the customer with high quality products undoubtedly determines the stable position on the market. The aim of the study was to analyse the cost and value of the technological process of doors in the context of creating added value and to identify unnecessary processes (not creating added value) in relation to which appropriate corrective actions could contribute to their elimination. Thanks to the application of remedial measures, consistent with the lean manufacturing concept, the study eliminated, among other things, operations related to unnecessary transport and storage of products, which resulted in both the reduction of time and costs of process implementation.

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## 1. Introduction

The functioning of enterprises depends on the processes they implement, which exist in a natural way regardless of whether they are identified and consciously managed or not (Grajewski, 2016; Winiowski, 2017). A process is commonly defined as a related group of tasks whose common result is of value to the client (Nowosielski, 2009; Wu et al., 2019) external and internal - one of the organizational units, in accordance with the principle of internal marketization (Grajewski, 2012; Danilova, 2019). Process identification, which is a prelude to process management, is based on the identification and execution of an initial characterization of a set of economic processes of a key importance for a particular enterprise (Czekaj, 2009; Hammer, 1999; Tseng, 2019).

Process Orientation recommends a holistic approach to processes as related activities, which makes it possible to identify them in order to better understand the principles of the company's functioning and value creation mechanisms (Ossowski, 2012; Alinejad, 2019).

## 2. Value added processes

The essence of modelling and process implementation is to transform the initial resources into final resources with the highest possible added value for potential buyers (Ossowski,

2012; Hammer et al., 2003; Heravi, 2019). Within the framework of the quality management system model, the foundations, such as processes, activities creating added value were indicated. In other words, customer requirements were transferred to the area of production (or service provision) so that the offered product (or service) would satisfy the customer. In the ISO 9001 standard, this approach has been determined as the following relationship: customer requirements (input) - product manufacture - product (output) (Szczepańska, 2010). Therefore, added value should be understood as the difference between the price the purchaser is willing to pay for the extended product and the cost of producing the product and delivering it to the customer (Krawczyk, 2007). The activities that contribute to the improvement of the customer's opinion of a product significantly affect the creation of added value (Lim et al., 2019; Bettman, 1996). Added value is one of the most objective measures of the effectiveness of a company's operations, as it makes it possible to separate such generated value from the value contained in purchased materials, raw materials and services (Wołodkiewicz-Donimirski, 2009).

Characteristics of the structure of individual categories of the process is a necessary stage, which to a large extent determines the effect of the implementation of the process, which (apart from its basic purpose) should include the creation of added value for customers (Kulińska, 2008). Figure 1 presents the analysis of processes in the context of creating added value.

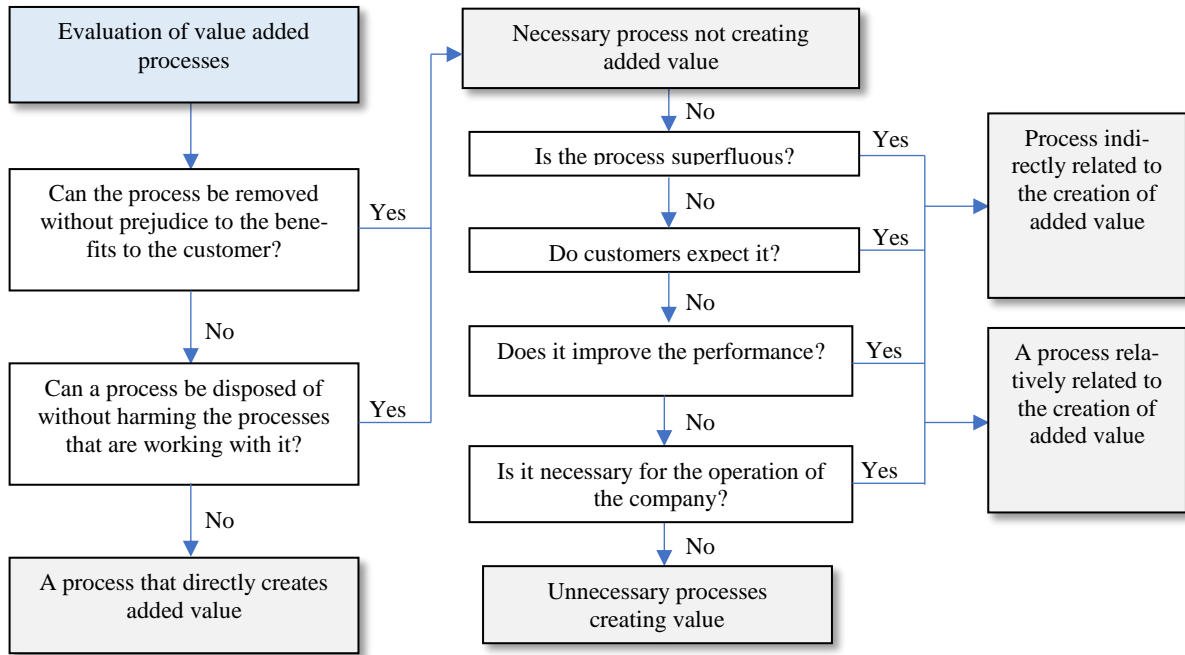


Fig. 1. Algorithm for evaluating processes in the context of value added

The algorithm shown in Figure 1 is interpreted by dividing processes into (Blaik, 2001; Ossowski, 2012; Kruczek et al., 2008):

- Directly value-adding processes with a direct and close relationship to the purchaser - primary/basic processes, among which the main and auxiliary processes are distinguished,
- The processes indirectly creating added value are characterised by an indirect relationship with the purchaser - secondary (secondary) processes which support the processes directly creating added value and, thus, contribute to its value,
- Processes relatively related to the creation of added value have a conditional relationship with the purchaser - the tertiary processes, in terms of time and in terms of substance, are significantly distant from the original processes.

The variety of factors influencing the value parameter makes it possible for their configurations to shape the potential and performance of a manufacturing company in a variety of ways. The value created by the implementation of system processes, diversified in its characteristics, may become one of the parameters used to assess quality management. However, in order to fulfil this condition, it is necessary to use an orientation that is closely linked to the processes in the company (Krupa, 2006; Dobiegała-Korona et al., 2006). Then adapting the analytical apparatus to the needs of value estimation (or valuation) will enable its multidimensional implications in the quality management concept. This value can be created or destroyed from the point of view of quality management principles (process and system approach). For this reason, it becomes important not only to identify the sources of value in

processes, but also the mechanisms that influence it (Szczepańska, 2010).

## 2. Experimental

The aim of the study was to analyse the technological process of doors in the context of value added and to identify unnecessary (non-value-adding) processes present in the production of the product, in relation to which appropriate corrective and preventive actions could contribute to their elimination.

The reason for the research was the willingness to reduce the costs of the technological process of interior doors and the willingness to undertake improvement activities in accordance with the concept of continuous process improvement implemented in the company - Kaizen. The survey was conducted in the 2nd quarter of 2019. in one of the production companies located in the southern part of Poland.

The algorithm presented in Figure 1 has been translated into technological operations. The manufacturing process of the inside frame door in technological terms micro-organised and the division of all operations in the process into those that create added value (1), do not create added value but are necessary for the manufacture of the device (2) and those that are redundant - do not create added value (3) (Table 1). Operations indirectly creating value added and relatively related to the creation of this value are included in the group of the second division of operations.

The technological process of the tested product was analysed in terms of the duration of the operation and the creation of added value. The result of the analysis showed that the manufacturing process consists of 22 operations with a total time of 10 hours 16 minutes and 30 seconds. Out of all operations, only 12 operations create added value and have an implementation time of 1 hour and 9 minutes.

**Table 1.** The technological process of manufacturing frame doors

Lp.	Name of the operation	Duration (period)	Technological approach	Division of operations		
				1	2	3
1.	Transport of door leaf elements to the production department	30 min.	➡		-	
2.	Intermediate storage of door leaf components	3 hour	▽			-
3.	Manufacturing of frame elements, slats, ties, quarters	20 min.	●	+		
4.	Veneering	15 min.	●	+		
5.	Fitting	4 min.	●	+		
6.	Marking I	10 secs.	●		-	
7.	Transportation of the completed item	4 min.	➡		-	
8.	Processing of base and back frames	6 min.	●	+		
9.	Jumping	4 min.	●	+		
10.	Inter-operative control	2 min.	■	+		
11.	Application of touchwood film	1 min.	●	+		
12.	Marking II	20 secs	●			-
13.	Laying on transport racks	3 min.	●		-	
14.	Transportation of elements (crossbars, vertical frames, glass)	5 min.	➡		-	
15.	Folding the door leaf	1 min.	●	+		
16.	Pressing	4 min.	●	+		
17.	hardware installation	4 min.	●	+		
18.	Product transport	10 min.	➡		-	
19.	Quality control	3 min.	■	+		
20.	Packaging and marking	5 min.	●	+		
21.	Transport to the finished goods warehouse	15 min.	➡			-
22.	Storage of the finished product	5 hour	▽			-

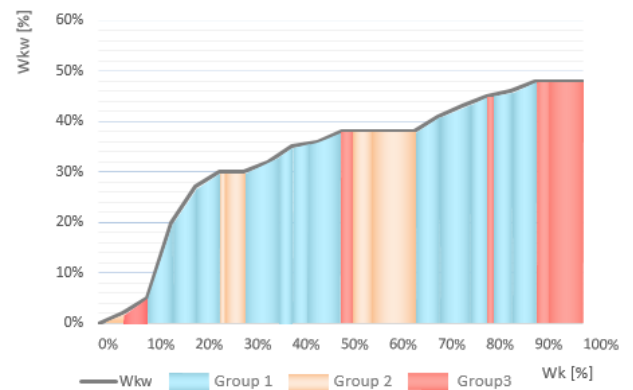
Among the operations that do not add value, six operations are necessary for the process. These operations are related to the inter-operational transport and the appropriate arrangement and transport of the manufactured elements for door leaf folding operations. Other operations are unnecessary and do not create added value to the product. The longest operations in this group include the storage of the finished product and intermediate storage of door leaf elements. The duration of these operations is related to the time after which the stored items will be received by an internal or external customer.

### 3. Results and discussion

In the framework of the added value assessment, the costs of individual operations were estimated in the presented process and the relations between the cost of implementation of operations ( $W_K$ ) and the adopted indicator of the  $W_{kw}$  were identified. This indicator defines the cost/value ratio of the product, the value of the product being the price the purchaser pays for the specific product.

The result of the conducted research is shown in Figure 2. The graph shows the technological process value chain with two indicators:  $W_{KW}$  i  $W_K$  –the indicators are expressed in percentages.

In Figure 2, the blue colour is used to mark the operations in group 1 - value-adding operations, the orange colour is used to mark the operations in group 2 - necessary operations that do not create added value, and the red colour is used to mark the operations that are unnecessary and do not create added value (group 3).



**Fig. 2.** The chart of added value creation for the analyzed process

As part of further process analysis, a summary of non-value-added lead times was made (Table 2).

**Table 2.** List of times of non-value-creating operations in the analyzed process

Technological operation	Time [hour]
Transport	1.066
Warehousing	8.000
Labelling	0.008
Laying on transport racks	0.050
<b>Total for a batch of 50 pieces</b>	<b>456.200</b>

In order to shorten the time of execution of operations which do not create added value, and thus reduce the costs of product execution, it was decided to implement corrective actions.

According to the data contained in Table 2, it can be seen that in the analyzed process, a significant amount of time is spent on transport (materials to the production hall, processed elements between workstations, products for final quality control and transport to the warehouse). An inadequately planned and set technological process contributes to the generation of losses. The mitigation measures used a methodology consistent with the Lean Manufacturing concept. The design of the production line took into account the issue of the speed of

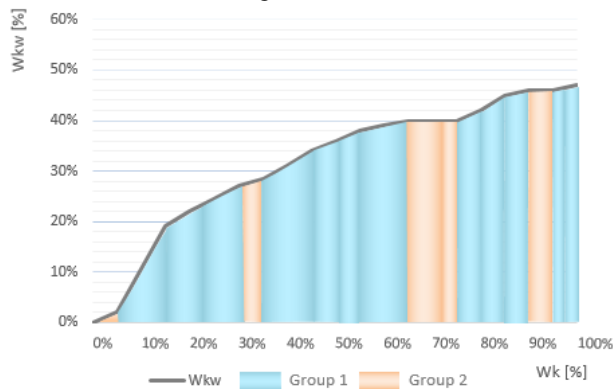
flow of the processed elements of the product, by determining a streamline which, according to its importance, eliminates excessive transport between the production halls. In addition, measures have been taken to reorganise the workstations themselves, which has made it possible to reduce transport time between the workstations.

The data in Table 2 also indicate high storage costs. As part of measures to minimise costs resulting from inefficient storage, a just-in-time management was implemented.

The issue of product labelling, although not very costly, was considered unnecessary after further analysis. Instead of creating new labels, it was decided to adjust the labels from the „Labeling I” operation to include additional information.

The operation of laying the product on transport racks is necessary to make the product in the way it is made. No changes have been introduced.

After the implementation of the changes, a summary of the technological process value chain was prepared, taking into account the  $W_{KW}$  i  $W_K$  (Figure 3).



**Fig. 3.** Graph of added value creation for the analyzed process after implementation of corrective actions

The implementation of remedial actions contributed to the elimination of unnecessary operations which did not create added value in the analysed process. In addition, thanks to the reorganisation of workstations and production line, it was possible to reduce the time needed to carry out operations that do not create added value but are necessary for the process (Table 3).

**Table 3.** List of times of non-value-creating operations in the analyzed process after implementation of corrective actions

Technological operation	Time [hour]
Transport	0.222
Warehousing	0.000
Labelling	0.002
Laying on transport racks	0.050
<b>Total for a batch of 50 pieces</b>	<b>13.700</b>

The developed lists of times of operations which do not create value in the analysed process indicate that thanks to the implementation of remedial measures, the time of operation execution (per 50 pieces per batch) decreased by 96.6%, which is at the same time connected with the reduction of costs of the finished product execution.

#### 4. Summary and conclusion

Maintaining effective processes and providing the customer with high quality products undoubtedly determines the stable position on the market. The quality of processes depends also to a large extent on the modernity of the product and organizational solutions applied in the company.

The study optimises the technological process of the door in terms of creating added value. Thanks to the application of countermeasures in line with the Lean Manufacturing concept, unnecessary operations that did not create added value were eliminated and the time of some of the operations that do not create added value but are necessary for the process was reduced. In addition, the introduced improvement has contributed to the reduction of process costs.

The proposed sequence of the cost-value method is a useful and effective way of analysing technological processes, which can be practised in different production companies.

Future directions of research will be related to the analysis of other production processes functioning in the examined company.

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## 内门工艺流程分析

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### 關鍵詞

工艺流程  
质量管理  
增值

### 摘要

有效流程的设计和正确实施以及为客户提供高质量的产品无疑将确定其在市场上的稳定地位。该研究的目的是在创造增值的背景下分析门的技术过程的成本和价值，并确定与之相关的不必要的过程（而非创造增值），适当的纠正措施可能有助于消除这些过程。由于采取了与精益生产理念相一致的补救措施，因此该研究消除了与产品不必要的运输和存储相关的操作，从而减少了流程时间和成本。