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AN ANALYSIS AND IMPROVEMENT OF THE PRODUCTION PROCESS OF EXTERNAL DOORS

The study aimed to conduct a cost-value analysis of the production process of a newly introduced batch of external doors in the context of value-added creation and to identify redundant processes that do not create added value and for which appropriate corrective actions could contribute to their elimination. The result of applying improvement actions following the lean management concept was the optimization time nationalized analyzed by eliminating, among others, operations related to unnecessary transport and storage of products. In addition, the optimization production process impacted both shortening the process implementation time and reducing the costs of its implementation. Further activities will be related to the use of the presented methodology to analyze the processes implemented in the company in order to increase their efficiency.

Keywords: quality, cost, production engineering, improvement.

1. INTRODUCTION

The need for improvement in companies has been around for a long time, but in today's rapidly changing marketplace, it has become essential (Liker and Franz, 2013; Womack and Jones, 2012; Ostasz et. al., 2020; Mentel and Hajduk-Stelmachowicz, 2020; Wolniak and Skotnicka, 2008). The requirement to be a flexible, efficient, growth-oriented enterprise and adapt quickly to a changing environment indicates the primary rationale for pursuing excellence and remaining competitive. Improvement can cover various aspects of the company, for example, processes, activities, products and services (Wolniak, 2013; Alinejad and Anvari, 2019; Lim et. al., 2019; Pacana et al., 2019).

Currently, many enterprises use the process approach in management because the identification of processes occurring in the organization deepens and interprets the creation of added value, while their improvement increases the efficiency of implementation and the level of the buyers' satisfaction (Lichtarski, 2015; Van Looy, 2021; Zuhaira and Ahmad 2021). Companies implement various methods and management concepts that use a process approach, for example, TQM (Total Quality Management) (Permana et. al., 2021; Lasrado

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and Nyadzayo, 2020; Tasleem et. al., 2016); Lean Management (Moyano-Fuentes et. al., 2021; Maldonado et. al., 2020), Six Sigma (Simanova and Gejdos, 2021; Raval et. al., 2020). Quality Management System (QMS) according to ISO standards (Sfreddo et. al., 2021; Pacana and Ulewicz, 2020). Moreover, companies seek additional benefits through their integration (Montgomery, 2013; Soare, 2012; Salah et. al., 2010; Sa et al., 2020; Youssef and Youssef, 2018). Their practices indicate the need to implement a multi-step process of process improvement and mechanisms to support their improvement and management. Essential support in the context of process improvement is the provision of adequate human resources who will be able to effectively manage and improve the processes (Bessant et. al., 2001; Yen-Tsang et. al., 2015).

The study aimed to carry out a cost-value analysis of the production process of a newly introduced batch of external doors in the context of value-added creation and to identify redundant processes that do not create added value and for which appropriate corrective actions could contribute to their elimination.

2. SCOPE AND SUBJECT MATTER

Due to a decrease in efficiency, the desire to reduce costs of the production process and the desire to implement improvements, the research subject was the production process of a newly implemented product – external doors. The survey was conducted in Q4 2019. in one of the manufacturing companies (Erkado) located in the southern part of Poland.

3. RESEARCH METHODOLOGY

In the study, it was decided to identify the structures of individual categories of the production process of external doors, which is a determinant of the effects of its Implementation, which (in addition to its primary purpose) include the creation of added value for customers. The methodology of process analysis in terms of value-added generation used in this study is presented in Figure 1.

The implementation of process evaluation in the context of value-added starts with answering two fundamental questions, “Can the process be eliminated without compromising the benefits achieved by the customer?” and “Can the process be eliminated without compromising the cooperating processes?”. If both questions are answered in the negative, it means that we are dealing with a process directly related to the creation of added value. However, if the answer is yes, it is likely that the process does not create added value. However, not all processes that do not directly add value are processes that need to be removed.

On the other hand, negative answers prove that the analysis is not related to the creation of added value – these are unnecessary processes. This type of activity adversely affects the process as it generates additional costs and increases the process time.

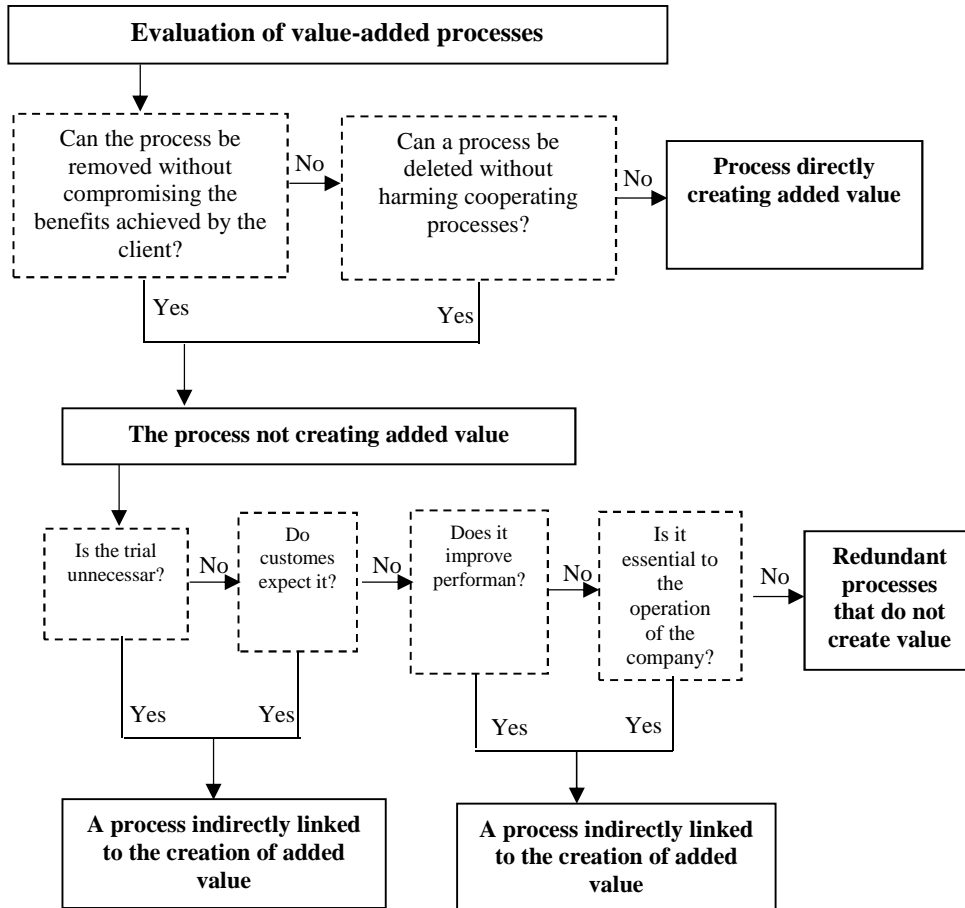


Figure 1. Algorithm for evaluating processes in the context of creating added value

Source: Own study based on: (Kulińska, pdf).

4. RESULTS AND DISCUSSION

The analyzed process of external doors along with the division of operations into operations creating added value (1), operations not creating added value but necessary to produce the product (2) and redundant operations – not creating added value (3) are presented in Table 1. The second group of the breakdown of operations includes operations indirectly creating value-added and those relatively related to value creation.



The production process of the studied product was analyzed for the duration of individual operations and the creation of added value. The analysis showed that the manufacturing process consists of 32 operations with 7 hours, 31 minutes and 5 seconds. Among all operations, only 22 create added value and their execution time is 1 hour and 38 minutes. Six operations do not add value to the manufactured product. The most extended

operations in this group include storage of the finished product and marking. The duration of the most extended operation is related to the time after which the stored items will be transferred to an external customer.

Table 1. Exterior door process chart

		PRODUCTION PROCESS FLOW SHEET						
PRODUCT NAME:		EXTERNAL DOORS						
Lp.	Name of the manufacturing process operation	Device/stand	Technological approach				Breakdown of operations	Duration
								
1.	Collection of raw materials and semi-finished products from storage	-	X				(2)	10 min
2.	Transport to the production department	-		X			(2)	13 min
3.	Cutting of wooden frames	Rover C6	X				(1)	5 min
4.	Production of frame elements, strips, bands, quarter rounds	Sitemap	X				(1)	20 min
5.	Routing holes for fittings and seals	Manual station	X				(1)	4 min
6.	ferrule	Manual station	X				(1)	3 min
7.	Packaging	Manual station	X				(3)	6 min
8.	Marking I	Manual station	X				(2)	20 s
9.	Routing of base frames	Rover C6 / Felder	X				(1)	4 min
10.	Milling of crossbars	Rover C6	X				(1)	2 min
11.	Drilling	Askla drilling machine	X				(1)	1 min
12.	Tenoning	Tenoning machine	X				(1)	1 min
13.	Pin installation	Assembly station	X				(1)	1 min
14.	Interoperation inspection	Inspection stand			X		(1)	3 min
15.	Processing of vertical frames	Rover 2	X				(1)	3 min
16.	Shortening	Askel saw	X				(1)	1 min
17.	Routing of the upper rebate	Rover C6 / Felder	X				(1)	1 min

Table 1 (cont.). Exterior door process chart

		PRODUCTION PROCESS FLOW SHEET						
PRODUCT NAME:		EXTERNAL DOORS						
Lp.	Name of the manufacturing process operation	Device/stand	Technological approach				Breakdown of operations	Duration
								
18.	Drilling holes for dowels, hinges and lock	Askla drilling machine	X				(1)	4 min
19.	Marking II	Tunnel	X				(3)	20 s
20.	Receiving inspection	Inspection stand			X		(1)	5 min
21.	Arrangement on transport racks	Tunnel	X				(2)	3 min
22.	Selection of elements (crossbars, vertical frames, glass)	Position. assembly	X				(2)	4 min
23.	Installation of waterproof plywood	Edge banding machine	X				(1)	6 min
24.	Filing	Position. assembly	X				(1)	3 min
25.	Polyurethane foam padding	Manual station	X				(1)	12 min
26.	Ironing	Diaphragm press	X				(1)	10 min
27.	Fitting of fittings	Position. assembly	X				(1)	2 min
28.	Quality Control	Inspection stand			X		(1)	4 min
29.	Packaging	Tunnel	X				(1)	5 min
30.	Marking III	Tunnel	X				(3)	25 s
31.	Transport to finished goods warehouse	-		X			(3)	15 min
32.	Storage	Magazine				X	(3)	Five h.

Source: Own study.

In order to assess the added value in the examined process, the costs of particular operations were estimated. Then the dependence between the cost of operation (WK) and the adopted indicator Wkw were identified. The indicator used determines the relation between the costs and the product's value. (The value of the product means the price the buyer pays for a particular product.) The result of the analysis is shown in Figure 2. The chart shows the value chain of the production process, including the WKw and WK indicators expressed in percentage.

In Figure 2, Group 1 refers to activities that are part of the process and add value. Group 2 refers to operations that do not add value but are necessary to be performed. Group 3 refers to operations that are redundant and do not add value.

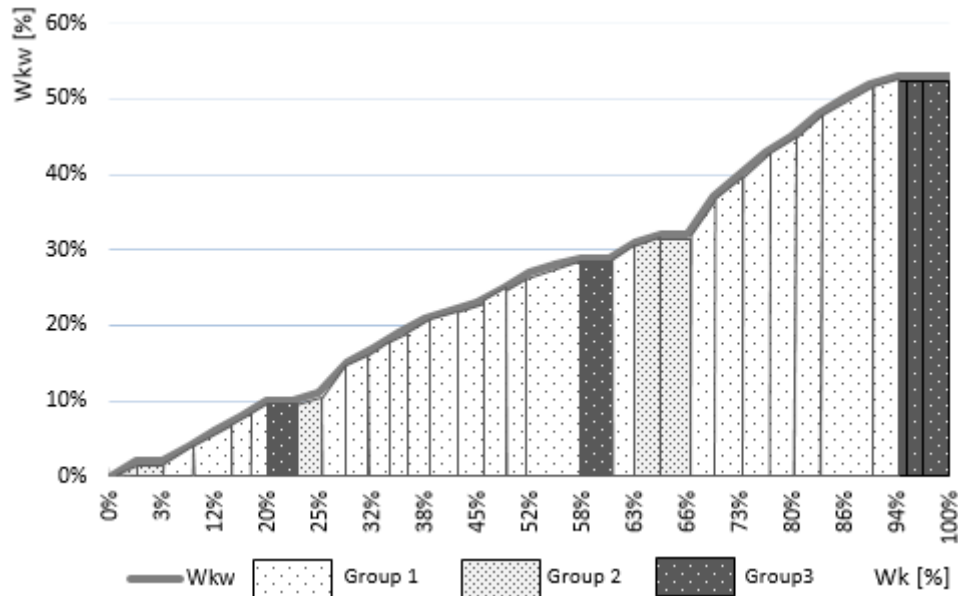


Figure 2. Diagram of the creation of added value of the analyzed process

Source: Own study.

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

Table 2. Summary of the duration of non-value-added operations

Technological operation	Time for one [h]	Time for a batch of 70 [h]
Packaging	0.1	7
Signage	0.0125	0.875
Transport	0.25	17.5
Storage	5	350
Total	5.3625	375.375

Source: Own study.

The data in Table 2 show a large share of warehousing time compared to other non-value-added operations. Therefore, as part of the activities to minimize inefficiencies in warehousing, management under the just-in-time method were implemented. This method involves the complete elimination of waste by supplying each production process with all the required items at the required time and in the required quantity.

Based on the analysis (Table 2), it can be seen that a significant amount of time is also consumed by transport (of materials to the production hall and transport to the warehouse). Therefore, the remedial actions used a methodology consistent with the concept of Lean Manufacturing. Furthermore, when designing the new production line, the issue of the speed of the flow of the machined elements of the product was taken into consideration by

appointing a streamline, which, according to its essence, eliminates excessive transport between the production halls. In addition, actions have been taken to restructure the organizations themselves, allowing them to reduce transport time between workstations and eliminate “packing operations”.

Although it does not generate high costs, after more analysis, the issue of product marking was decided that the operation Marking II and Marking III are unnecessary. Instead of creating new labels, it was decided to adopt the labels from operation “Labelling I” to include additional information.

The implementation of improvement actions contributed to the elimination of redundant operations in the analysis. Additionally, thanks to the reorganization of the production line and workstations, the execution time of operations that do not create added value but are necessary for the realization process was reduced (Table 3).

Table 3. Summary of the duration of non-value added operations after implementation of improvement actions

Technological operation	Time for one [h]	Time for a batch of 70 [h]
Packaging	0	0
Signage	0,005	0.35
Transport	0.083	5.81
Storage	0	0
Total	0.088	6.16

Source: Own study.

The presented times of non-value-creating operations in Table 2 and Table 3 indicate the success of the implemented improvement actions. Because of their implementation, the operation time per batch of 70 products decreased by 98.35%, which is also associated with a decrease in the finished product cost.

5. SUMMARY AND CONCLUSION

The foundation of production process improvement is the effective connection and use of production elements resulting from the need to meet customer requirements, increase competitiveness, increase the essence of flexibility, both internal and external. The quality of the processes also depends mainly on the modernity of the product and the organizational organization applied in the company.

Among the many possibilities of improving the organization, activities related to increasing the effectiveness of implemented processes play an important role. therefore, it seems reasonable to undertake cost-value analysis of the main processes in manufacturing companies. The aim of the research was to perform a cost-value analysis of the production process in relation to the newly introduced batch of external doors within the framework of creating added value and to identify unnecessary processes that do not create added value and in relation to which appropriate corrective actions could contribute to their elimination. The study optimised the production process of external doors in terms of creating added value. Because of the implementation of improvement actions in accordance with the Lean Management concept, the time of some operations, which do not create added value but are necessary to carry out the process, was reduced and unnecessary operations, which did not

create added value, were eliminated. Moreover, the implemented improvements reduced the costs of process execution, increasing the efficiency of the process and the timeliness of task completion.

The proposed cost-value analysis is a useful and effective way of analyzing processes, which can be practised in various enterprises.

Further research directions will concern the analysis of other production processes in the investigated enterprise.

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