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OPTIMIZATION OF TRANSPORT PROCESSES IN AN ENTERPRISE BY THE SMED METHOD

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Objective: The objective of the article was to present the basic issues related to the functioning of transport processes in an enterprise, getting acquainted with and analysing selected areas of transport of the observed enterprise and showing how the practical use of information on the existing transport processes in the enterprise using selected methods and research tools allows for process optimisation.
Design/methodology/approach: To determine the causes of the problem, it was decided to use quality management tools, i.e. the five whys analysis and fishbone diagram. In order to perform a detailed analysis, it was decided to use the SMED method to parameterise the implementation of the transport process.
Findings: The analysis carried out before and after the introduction of the changes allowed to determine whether the problem was solved and what benefits the company gained. Examining the time of individual transport processes allowed to implement a new IT system, which contributed to the development of the company and allowed to save a large amount of capital.
Originality/value: The results of the study can be used in strategic decisions of the company in the area of optimisation of transport processes.

Keywords: transport process, optimisation, SMED.

1. Introduction

The process is understood as consecutive and causally related defined changes (activities) (Twaróg, 2016, p. 26). The process is therefore a set of activities that transform the factors in the initial phase of the process into a result (starting factors) (Kubicki, Kuriata, 2000, p. 20).

According to the literature, "the transport process is understood as a set of organizational, executive and administrative activities carried out in a specific order in connection with the movement of loads by means of transport" (Jacyna, 2016).

Other definitions of the transport process appear in the literature on the subject, the meaning of which is identical to the definition presented above. One of them defines the transport process "as a series of coordinated executive, organizational and commercial activities that are to lead to the movement of cargo from one or more dispatch points, to one or more reception points, in the most efficient way possible using appropriate means of transport" (Zgutka, Rokicki, 2015, pp. 82-83).

In the simplest way, the transport process can be defined as a sequence of specific tasks interrelated with each other, as a result of which specific goods will be delivered to the indicated recipient (Starkowski, 2016, p. 1546).

S. Kauf in his work Transport and storage defined the transport process as a set of coordinated activities related to the time-space transformation of products and information, in accordance with the terms of a contract between the carrier and the customer (Kauf, 2016, p. 140).

The transport process itself consists of three stages: loading, actual transport and unloading, depending on the complexity of the transport process, these parts may be increased by additional processes such as: preparation of the goods for transport, storage, acceptance of the cargo along with its handling in cooperation with other means of transport or activities related to the forwarding service of the recipients (Goździewska, 2012, p. 754).

Organizational, executive and commercial activities are three basic activities that make up the transport process (Michalak, Staniewska, 2010, pp. 104-106). The organizational activities cover designing an appropriate transport route and preparing the necessary transport documentation. Executive activities are the transport of goods and other processes related to it, i.e. loading, movement and unloading. Each of these processes can be expanded with a number of operations related to the type of cargo, route length, etc.

2. Analysis and determination of the cause of the research problem

In order to achieve goals, the company decided to increase its scale of operations by implementing a larger number of transport orders, which resulted in the number of orders handled increasing by 20% per month. Such a situation resulted in problems with maintaining the deadlines of cargo delivery, which resulted in an increase in complaints by 13%. Therefore, the company decided to set up a team whose goal was to solve the problem. The team is composed of the following people:

- administration employee,
- logistics and transport specialist,

- driver,
- accountant.

To determine the causes of the problem, it was decided to use quality management tools, i.e. five whys analysis and fishbone diagram (Hubert, 2006, pp. 2-6). As shown by the five whys, the main reason for the increase in the level of complaints related to the increase in the scale of the organization's operation is the lack of IT adaptation to the large number of supported orders. During the meeting, the team members indicated that this is a clear problem due to the fact that the current management of orders takes place on the basis of an Excel sheet. A large number of data is the reason why very often drivers receive an inefficient route plan for delivery orders in a given period, which results in the fact that drivers often travel to one area several times causing delays in delivery, and an increase in the operating costs of the organization.

In order to present a wide range of problems that affect the delays in the execution of orders, it was also decided to conduct an analysis using the Ishikawa diagram. This tool allowed to see the real picture of problems occurring at various levels in the organization.

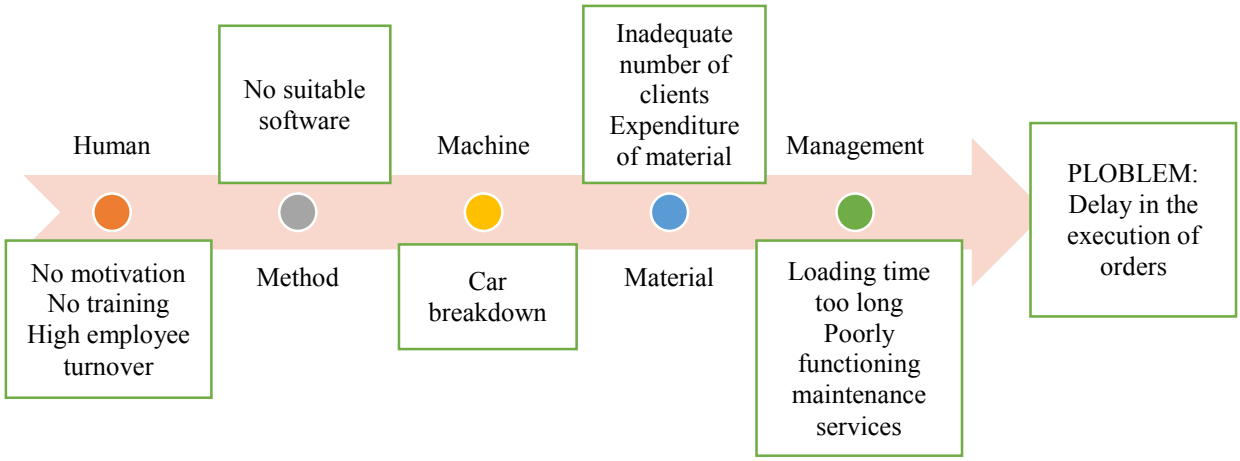

Figure 1. Ishikawa diagram showing the analysis of the examined problem. Source: Own study based on observations of a transport company.

The above analysis shows that there are more problems in the company that contribute to an increased number of complaints. The team members indicated a number of problems such as high employee rotation and thus the lack or ineffective training of the management staff. Again, it was pointed out that a big problem is the lack of an appropriate system for comprehensive order management, which affects the supervision of the vehicle fleet. The team members also pointed out the fact that it very often happens that vehicles fail, and the waiting time for repair extends quite significantly, which negatively affects the timeliness of deliveries.

The above study allowed to select areas that should be subjected to an in-depth analysis and to suggest activities that will allow for a more efficient implementation of the transport process.

In order to perform a detailed analysis, it was decided to use the SMED method to parameterize the implementation of the transport process. SMED (Single Minute Exchange of Die) is a method enabling comprehensive reduction of the time of machine and process

changeovers, as it turned out also in transport processes (Shigeo, 1986; Womack, 2001, pp. 10-15). It allows results to be achieved in a very short period, without having to bear heavy financial burdens. It consists of three stages: The first stage is the division of operations. The second stage is observation and analysis. The third stage is to implement the changes.

Time measurements were made by the logistics specialist when handling 2 transport orders on different days. The measurement results obtained in Tables 1, 2, 3 and 4 are presented below.

Table 1.
Measurement results obtained during the first transport order

TIME MEASUREMENT WORKSHEET				
Change	1	**Order number**	2345987	
Date	17 November 2021	**Order type**	recurring	
Operation	Transport	**Driver's number**	1298	
		Prepared by	**Logistics and Transport Specialist**	
Work item name	**Start point**	**End point**	**Value expressed in minutes**	**Additional notes (non-cyclical operations)**
1. Preparatory activities	**06:00**	**10:30**	163	
Entering orders in the register	06:00	07:13	73	
Establishing a daily delivery schedule	07:13	08:10	57	10 minutes waiting time for information from the sales department employee (incomplete information on the order)
Handing over the schedule for implementation	08:10	08:25	15	
Preparing transport units	08:25	08:43	18	
2. Implementing the transport order	**08:43**	**11:30**	107	
Arriving at the customer's	08:43	9:20	37	13 min car refuelling
Waiting for loading	9:20	09:35	15	
Loading	09:35	10:00	25	
Securing the transport	10:00	10:15	15	8 min problem with the belt clamp (tool blocking)
Waiting for documents to be issued	10:15	10:30	15	
Transport to the end customer	10:30	11:30	60	25 min failure (overheated coolant) 21 min road accident
				(waiting in traffic)
3. Completing the transport order	**11:30**	**12:20**	50	
Waiting for unloading	11:30	11:43	13	
Unloading	11:43	12:05	22	
Waiting for documents to be issued	12:05	12:15	10	
Closing the order	12:15	12:20	5	

Source: Own study based on internal materials of a transport company.

Table 2.
Sum of times and percentage of individual transport processes obtained during the first transport order

Operations	Time [min]	Share [%]
Preparatory activities	163	51
Execution of the transport order	107	33
Transport order completion	50	16
Total order time	320	100

Source: Own study based on internal materials of a transport company.

Table 3.
Measurement results obtained during the second transport order

TIME MEASUREMENT WORKSHEET				
Change	1	**Order number**	2346754	
Date	20 January 2022	**Order type**	recurring	
Operation	Transport	**Driver's number**	1298	
		Prepared by	**Logistics and Transport Specialist**	
Work item name	**Start point**	**End point**	**Value expressed in minutes**	**Additional notes (non-cyclical operations)**
1. Preparatory activities	**06:00**	**10:30**	166	
Entering orders in the register	06:00	07:18	78	
Establishing a daily delivery schedule	07:18	08:15	53	
Handing over the schedule for implementation	08:15	08:31	16	
Preparing transport units	08:31	08:50	19	No belts and tensioners available (waiting for delivery from a warehouse)
2. Implementing the transport order	**08:50**	**14:20**	330	
Arriving at the customer's	08:50	9:30	40	20 min refuelling
Waiting for loading	9:30	09:40	10	
Loading	09:40	10:00	20	
Securing the transport	10:00	10:08	8	
Waiting for documents to be issued	10:08	10:30	22	
Transport to the end customer	10:30	14:20	230	170 min failure (overheated coolant)
3. Completing the transport order	**14:20**	**12:20**	85	
Waiting for unloading	14:20	15:00	40	30 minutes of extra waiting time for being late
Unloading	15:00	15:30	30	
Waiting for documents to be issued	15:30	15:40	10	
Closing the order	15:40	15:45	5	

Source: Own study based on internal materials of a transport company.

Table 4.
Sum of times and percentage of individual transport processes obtained during the second transport order

Operations	Time [min]	Share [%]
Preparatory activities	166	29
Execution of the transport order	330	57
Transport order completion	85	14
Total order time	581	100

Source: Own study based on internal materials of a transport company.

In both cases, the preparatory activities took a similar amount of time of about 160 minutes. It was clearly observed that the order execution time was significantly different due to the occurrence of failures during transport. In both cases, there was a failure, in the first one it lasted 25 minutes. However, in the second one, it lasted as many as 170 minutes, which caused significant delays in delivery, by more than 3 hours. This also impacted the longer waiting time for unloading and thus the delay and waste of time expanded. During the measurements, a number of irregularities were observed, which significantly impacted the efficiency of the execution of orders, i.e.:

- waiting for information from sales department employees if the order is incomplete or inconsistent,
- refuelling the vehicle,
- vehicle failure,
- waiting in the queue for unloading due to a significant delay.

3. Implementing changes

The above analysis made it clear where the greatest losses of time occur in enterprise X and indicated the places that require changes to be introduced, thanks to which the transport process will be carried out faster and more effectively. The following table presents the tasks the implementation of which will increase the efficiency of transport orders.

Table 5.
Register and status of implementation of tasks to be implemented in a transport company

No.	Task description	Date of execution	Person responsible	Implementation status
1	Tender announcement and selection of a system for comprehensive management of transport and vehicle fleet	by the end of May 2020	Company owner	completed
2	Implementing system XXX	by the end of October 2020	Representatives of the company implementing the system	completed

Cont. table 5.

3	Training for employees regarding the use of system XXX	by 15 November 2020	Representatives of the company implementing the system	completed
4	Introduction of TPM for the vehicle fleet	by the end of June 2020	UR Master	completed
5	Introduction of SUR standby shifts	by the end of June 2020	UR Master	completed
6	Purchase of new belts and clamps	by 1 April 2020	Company owner	completed
7	Introduction of emergency instructions	by September 2021	Logistics and Transport Specialist	completed
8	Signing a contract with a partner transport company for occasional execution of orders	by 1 January 2021	Logistics and Transportation Specialist Company Owner	completed

Source: Own study based on internal materials of a transport company.

Re. 1, 2, 3. In order to reduce the waiting time for entering orders into the system and waiting for the creation of a daily delivery plan, it was decided to purchase a system for comprehensive management of a transport company. The software is to be comprehensive and be able to remotely enter orders into the system, automatically generate a daily delivery plans based on the most optimum routes. An additional but a priority guideline is the possibility of comprehensive management of the vehicle fleet. It is expected that the system will contain information about drivers, mileage, condition of vehicles, current order in progress, fuel consumption, failures, delays. A very important guideline is that the system must have an advanced GPS that will determine effective routes and inform about delays on an ongoing basis. Completion of these tasks will eliminate time wasting and unnecessary operating costs.

Ad. 4, 5, 6. In order to avoid time losses related to vehicle breakdowns, it is recommended to introduce a prevention in SUR (Maintenance Service). Every day, according to the schedule, mechanics are obliged to carry out inspections and repairs of the vehicle fleet. Such actions will minimize losses associated with vehicle failures that are on the road, which is very expensive and causes a lot of problems. Early detection of failures will allow to respond faster.

Ad. 7. It was diagnosed that there is no instruction in the organization related to responding in emergency situations, when there is a shortage of vehicles as a result of accidents or failures, which causes delays in the execution of orders and, in the worst case, their cancellation, which adversely affects the company's image. The manual will clearly inform who needs to do what and when in order to maintain the continuity of deliveries.

Ad. 8. In order to protect the organization against various random events, i.e. the lack of available fleet in the event of failures or accidents, it was decided in reference to point 7, to establish a partnership with a transport company for occasional execution of orders in the case of different random situations occurring. Such an action will allow to maintain the continuity of execution of orders, and at the same time will allow to achieve success by the company.

4. Analysis and results after implementing changes

After implementing the changes described in the subsection, the company became orderly. Thanks to the rapid flow of information, the problem of transport delays has been minimized. This is evidenced by the fact that in February 2021, there was a decrease in complaints related to extensively long transport time by 8 percent, which allows to state that the change was effective.

In order to check to what extent the changes affected the execution of orders in March 2021, SMED analysis was carried out again, the following results were obtained.

Table 6.
Measurement results obtained during a transport order after introducing changes

TIME MEASUREMENT WORKSHEET				
Change	1	**Order number**	2609584	
Date	2 March 2021	**Order type**	recurring	
Operation	Transport	**Driver's number**	1298	
		Prepared by	**Logistics and Transport Specialist**	
Work item name	**Start point**	**End point**	**Value expressed in minutes**	**Additional notes (non-cyclical operations)**
1. Preparatory activities	**06:00**	**06:32**	42	
Entering orders in the register	06:00	06:05	5	
Establishing a daily delivery schedule	06:05	06:10	5	report automatically generated by the system
Handing over the schedule for implementation	06:10	06:12	2	report sent automatically by the system
Preparing transport units	06:12	06:32	30	
2. Implementing the transport order	**06:32**	**08:30**	118	
Arriving at the customer's	06:32	07:00	28	
Waiting for loading	07:00	07:10	10	
Loading	07:10	07:30	20	
Securing the transport	07:30	07:40	10	
Waiting for documents to be issued	07:40	07:50	10	
Transport to the end customer	07:50	08:30	40	10 min accident (no alternative route - system alert)
3. Completing the transport order	**08:30**	**09:16**	46	
Waiting for unloading	08:30	08:40	10	30 minutes of extra waiting time for being late
Unloading	08:40	09:00	20	
Waiting for documents to be issued	09:00	09:15	15	
Closing the order	09:15	09:16	1	

Source: Own study based on internal materials of a transport company.

Table 6.
Sum of times and percentage of individual transport processes obtained during a transport order after implementing changes

Operations	Time [min]	Share [%]
Preparatory activities	42	20
Execution of the transport order	118	57
Transport order completion	46	23
Total order time	206	100

Source: Own study based on internal materials of a transport company.

According to the SMED analysis, after implementing the changes, the execution time of orders decreased by about 45%, which is an excellent result for the company. The greatest time savings were achieved during preparatory activities, where the time was reduced by 120 minutes thanks to the use of an IT system to manage the organization, which automatically performs the work schedule based on the entered data and selects the most effective routes in real mode. The second very important process, which, thanks to optimization, brought the greatest time savings, was the operation of executing the transport order. Thanks to the introduction of vehicle fleet supervision by a special IT system and the implementation of daily TPMs for trucks, the failure rate decreased by more than 80%, as evidenced by the faster delivery time by more than 200 minutes.

Such a situation allowed to solve the research problem, because the level of complaints decreased by 8 percent. Due to the above, the company can grow on the transport services market. Due to the implemented changes, X recorded significant increases in revenues for completed orders. Due to eliminating losses, the costs of executing one transport order decreased by 30% (lower fuel consumption, no penalties for delays, lower operating costs of vehicles).

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