

**IMPROVEMENT OF SELECTED LOGISTICS PROCESSES
USING QUALITY ENGINEERING TOOLS**

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Abstract:

Increase in the number of orders, the increasing quality requirements and the speed of order preparation require implementation of new solutions and improvement of logistics processes. Any disruption that occurs during execution of an order often leads to customer dissatisfaction, as well as loss of his/her confidence. The article presents a case study of the use of quality engineering methods and tools to improve the e-commerce logistic process. This made it possible to identify and prioritize key issues, identify their causes, and formulate improvement and prevention measures.

Key words: *logistics, warehouse, e-commerce, quality, 5 Why, FMEA, improvement*

INTRODUCTION

Logistics processes are one of the most significant processes in an enterprise. Modern business environment requires from suppliers efficient and defect – free flow of materials and information. Therefore, well – executed logistics processes should integrate flows of material and information streams, and their essence is to coordinate these flows with other processes [10]. S. Krawczyk [9] defines a logistics process as a process that is related to other processes, while taking into account the following aspects: place, time, cost, efficiency. Typical logistics processes can be divided into primary and supporting processes, as shown in Table 1.

Primary processes are those that combine the processes of supply, production and distribution – they transform the

temporal, spatial, quantitative and qualitative properties of goods and information, i.e. warehouse operations, transshipment transport operations, and material management. On the other hand, supporting logistical processes include planning and decision making to shape, coordinate and optimize logistics systems [5, 12].

Improvement of logistics processes should be one of the core areas of the company's business focussed on improvement. Improvement should be oriented to one or more areas that can be identified as the following criteria: economic (e.g. reduction of logistical costs), technical (e.g. shortening of material storage time), organizational (e.g. improvement of information flow), social (e.g. improvement of customer service) and ecological (e.g. waste reduction) [4].

Table 1
Logistics processes

	Primary processes	Supporting processes
Processes of material and goods flow	Processes of material flow	
Storage	Planning of supplies, production, stocks	Logistics management
Transport	Giving instructions for shipment, execution of order	Controlling of logistics
Acceptance of goods	Product flow control	Research and development of logistics
Shipping of goods	Preparation of customer orders	Comprehensive coordination
Waste management	Planning of shipments, service and logistic support	Waste management
Service, logistic support		Service and logistic support management

Source: [2].

Improvement of a logistics process can be accomplished according to the following scheme:

1. Identification and prioritization of problems.
2. Selection of problems that will be most beneficial for the process improvement and capabilities (resources) of the organization.
3. Finding the root causes of the problem and where they occur in the process.
4. Development and implementation of improvement activities that will reduce or eliminate the problem.
5. Development and implementation of preventive actions to prevent future problems.
6. Implementation of control measures to check effectiveness of the changes.
7. Possible corrections of activities as a result of undertaken control activities [18].

Among the range of tools and methods used to improve processes, we can distinguish those that help identify problems, find the causes and sources of abnormalities, and those to help to develop and implement improvement and prevention efforts. The first group includes popular tools such as the Pareto (ABC) diagram, the control chart, the Ishikawa diagram (5M), 5 Why, the relationship diagram, etc. [1, 8, 11, 15]. The tools supporting the improvement and prevention efforts are first of all: FMEA, 8D, and DMAIC [11, 13, 14].

THE ANALYSED PROCESS

The selected warehouse mainly distributes sports articles and is responsible for supplying twenty – eight commercial units, i.e. large – format sports stores, as well as it manages e-commerce. There are number of logistics processes in the selected warehouse, consisting of: reception, storage, picking, releasing and shipping. Material flow is realized using internal transport and the flow of information is supported by the WMS (Warehouse Management System).

The shipment process in the e-commerce department will be subject to an analysis, which is a key task for the warehouse. It consists of several stages, which are presented in the following diagram (Figure 1).

The shipment process includes the following elements:

1. Order sending to the system.
2. Printing orders in departments – after orders are sent they are printed in the departments of the warehouse.
3. Picking items for orders. This process is extremely important for the proper functioning of e-commerce. Most orders consist of articles from different brands,

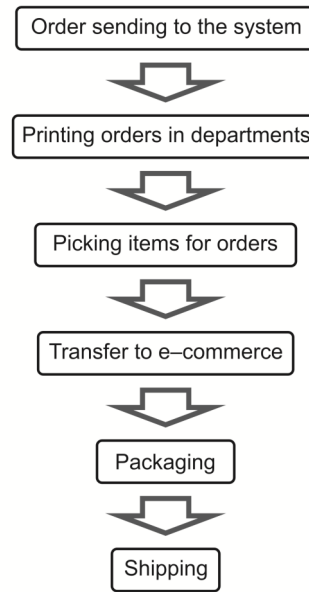


Fig. 1 Diagram of shipment process in the e-commerce department

Source: [3].

which means that the order is completed by different, independent departments. In case one of the departments has delay the entire order is incomplete and therefore the order cannot be completed on time.

4. Transfer to e-commerce – this involves delivering complete articles to the e-commerce department,
5. Packaging – the process of adequate packing the order as quickly as possible.
6. Shipping – is the process that takes place after the order is sorted. Packages and necessary information are sent.

The main measure of the process is the shipment time of the order to the customer, which is D + 1 (which means that the shipment will take place on the next day from the moment the customer placed the order).

IDENTIFICATION OF PROBLEMS

During the study, an interruption measurement sheet was introduced in the e-commerce department to identify inconsistencies that interfere with the shipping process. Figure 2 shows an example sheet.

All interruptions identified by the measuring sheets are listed in Table 2.

INTERRUPTION MEASUREMENT SHEET		
Department: e-commerce		
Date: 02.04.2017		
Shift: 1 st		
Leader: Jan Kowalski		
IDENTIFIED INTERRUPTIONS		
Interruption	Subprocess:	Temporary remedial action:
1. Delayed picking	Compilation	Phone to the shift supervisor
2.		
3.		

Fig. 2 Interruption measurement sheet

Table 2
Identified interruptions and problems in the shipping process

Item	Operation	Interruption	Number of observations
1.	Compilation	Incorrectly compiled articles	250
2.	Packing	Incorrectly sorted packages	200
3.	Compilation	Delayed completion	130
4.	Shipment	Delayed shipping	100
5.	Packaging	Destroyed articles	42

The most common interruptions in the e-commerce department that affect the quality of the shipment process are: incorrectly compiled articles (250 incidents) and incorrectly sorted parcels (200 cases). An operation in the process that generates the most incompatibilities is compilation (380 incidents – over 50% of all reported inconsistencies). Consequently, this element of the process has been selected for improvement.

CAUSES OF PROBLEMS

The next stage of the analysis is to diagnose the cause of the above disturbances i.e. incorrectly completed orders and late completion of orders. For diagnosis the 5 Why tool was used, which aims to identify the root cause of the problem. The results of the analysis are shown in the figures below (Figures 3 and 4).

The first to analyse were wrongly picked articles. This is most commonly occurring problem (250 times during the quarter). Thanks to the 5 Why tool, two main causes of problems have been identified: frequent failures of bar code scanners and unwieldy carts for order picking.

Delayed completion of orders occurred during the period considered 130 times. The main causes of these incidents were: permanent problems with the efficiency of the scanning system and the lack of experience of people performing the picking.

IMPROVEMENT MEASURES

The FMEA method was used to evaluate the identified disturbances during the shipment process, which allows for the verification of interfering factors and proposed improvement measures. The evaluation was done with three scales:

- Z – significance of the effect of defect,
- R – probability of defect occurrence,
- W – defect detection.

Each scale is assigned a rating scale of 1 to 10, while the product of these values shows us the level of probability of risk (RPN) that is associated with the occurrence of a particular disturbance [7]. Scale estimation was based on: prepared interruption measurement sheet, opinion of experienced employees at all levels of the company and the results of conducted internal audits. The results are shown in Table 3.

The FMEA analysis shows that the most likely risk of disruption to shipment was reported in the case of too fast introduction of new employees (RPN = 245) and unwieldy pickup carts (RPN = 72).

At a later stage of analysis, improvements and preventive actions were proposed and implemented, and their usefulness was also determined using the RPN indicator, as shown in Table 4.

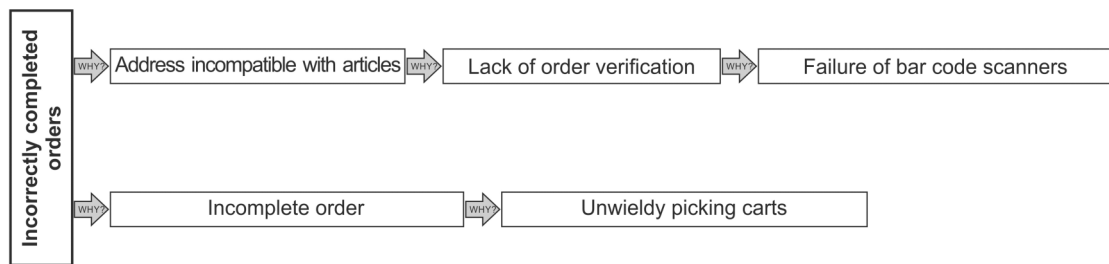


Fig. 3 The 5 Why analysis – incorrectly completed orders

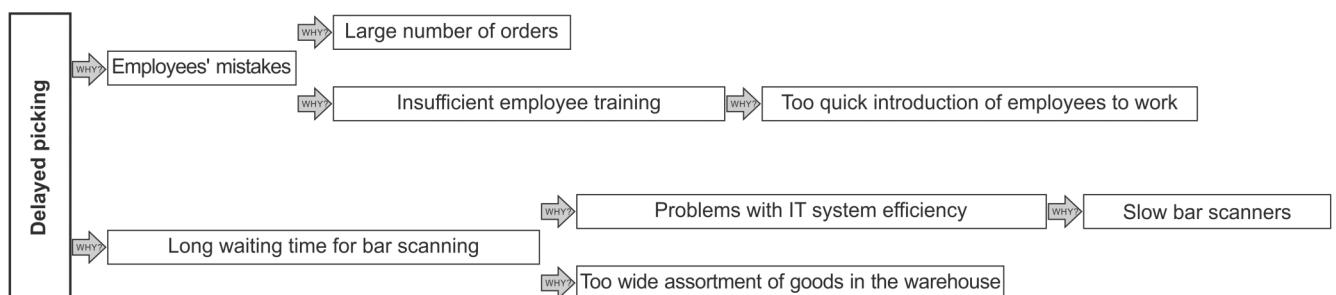


Fig. 4 Analysis of interruptions – delayed picking

Table 3
The FMEA analysis of the shipping process

Potential problem	Potential effects	Potential causes	Z	R	W	RPN
Incorrect completion of order	delayed delivery time	scanner failure	9	6	1	54
		unwieldy carts	9	4	2	72
Delayed completion of order	delivery not compliant with the order	too fast introduction of new employees	7	7	5	245
		slow code scanners	7	3	3	63

Table 4
The FMEA analysis after improvement measures

Potential causes	RPN before	Improvement measures	Preventive actions	Z	R	W	RPN after
scanner failure	54	Change of data collection technique	weekly work meetings	9	3	1	27
unwieldy carts	72	Replacement of carts	–	9	2	1	18
too fast introduction of new employees	245	Additional trainings trial period	Training records	7	5	4	140
	245		Independent work permit	7	4	2	56
slow code scanners	63	Technical abnormality sheet	weekly work meetings	7	2	2	28
	63		Change of data collection technique	weekly work meetings	7	1	1

The following solutions were chosen for implementation:

1. Changing the data collection technique, which will reduce the PRN for two causes: scanner failures and scan system slowdown.
2. Replacement of carts for the cause – unwieldy carts.
3. Introduction of trial period for new employees.

Change of data collection technique

The new technique that can be used to replace bar codes is RFID (Radio-frequency identification) [6]. In order to implement this solution in practice it is necessary to equip a warehouse with IT infrastructure based on Wi-Fi. Each workstation should be equipped with a computer (tablet) for data transfer and collection, a data reader and a printer. During manual scanning, which is currently practiced in the warehouse, the picker is able to complete about 350 orders, while the new technique it is about 1000 orders.

Replacement of carts

So far used carts were fitted with reusable trays of standard size (1 large or 2 small), which caused the small items to "be missed" while emptying the tray. The „Pick&Pack“ carts consist of shipping cartons, and picking consists of stacking articles into suitable cartons. These cartons immediately serve to pack ready – made orders, so after the completion the carton is closed with the ordered articles, labelled and sent immediately to shipping. This process saves time and costs. The only cost to be incurred by the warehouse will be the purchase of new multifunctional carts, which are shown in Figure 5.

Training of new employees

In case of employing new or seasonal workers, the scope of training has been extended. In addition to the theoretical and practical classes in the first period of work, any newly – employed worker will have a "tutor" implementing him/her into the process.



Fig. 5 Comparison of classic and „Pick & Pack“ cart
Source: [16, 17].

SUMMARY

Analysis of the non – compliance of the shipment process using tools such as interruption sheets, 5 Why and the FMEA method has illustrated that the shipping process in the e-commerce department of the selected warehouse is complex, and the interferences that are associated with its correct course are interrelated. During the analysis, the following disruptions to the shipment process were identified: delayed completion of orders, delayed shipment, destroyed articles, incorrectly sorted parcels and erroneously picked articles. Analysis with the 5 Why tool has helped to identify the causes that are responsible for the disruption during the shipping process. The most important are: faulty scanners, inoperative carts, slow – running scanners, under – trained pickers.

Thanks to the above results, the FMEA analysis has been performed, which has identified the reasons for the highest probability of risk (RPN) interruptions, namely: unwieldy carts, too fast introduction of new employees, lack of cooperation with the IT department.

The result of the actions was defining of improvement and preventive actions, i.e.:

- replacement of the bar code system with RFID technology,
- introduction of the „Pick&Pack” carts,
- change of training system of new employees.

Because of its low effectiveness, no additional training was decided.

Thanks to the use of tools and methods of quality engineering in the logistics process, it was possible to improve it, and the solutions proposed by the analysis helped to solve the most significant problems.

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