



ANALYSIS OF THE CAUSES OF MECHANICAL DAMAGE IN PRODUCTION OF FURNITURE FRONTS

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ABSTRACT

The analysis of the problem of the mechanical damage was made for a company manufacturing furniture and furniture fronts. From January to September the company identified 285 pieces of mechanically damaged products. The management of the company wanted to identify the source of the incompatibility; therefore, it was purposeful to analyse the problem of the mechanical damage using the sequence of the selected instruments of the quality management that enable this. Additionally, until now the company has not used the instruments of the quality managements to analyse the problems involving nonconformity, so it was important to show the company their practical use. The aim was to analyse the problem of the occurrence of the mechanical damage in fronts and furniture and to identify the root cause of the problem. Also to show the effective use of the sequence of the quality management instruments (i.e. 52WH method, Pareto-Lorenz diagram, Ishikawa diagram, 5Why method) to solve the problem of incompatibility. It was concluded that the root cause of the mechanical damage of fronts and furniture was the lack of management knowledge and awareness of the need to implement visualization principles in the company. The analysis and the proposed improvement actions may be practiced in other companies from both the production and service industries.

KEYWORDS

Quality, quality management techniques, improvement of production processes, the Pareto-Lorenz diagram, the Ishikawa diagram.

1. Introduction

The instruments of the quality management, which are colloquially called the tools and methods of the quality, are used to solve different types of problems occurring in the enterprises [16, 24]. The division of quality management instruments is conventional and the criteria by which the division is made are the way and time of impact on quality [9]. One can distinguish the rules, tools and methods of quality management [10]. The rules of quality management allow showing the attitude of employees and the whole enterprise to quality problems [17], in turn, the methods of quality management allow shaping the quality and the tools of quality management are used to select and analyse the data which are based on the quality management aspects [3, 22]. The use of tools and methods of quality management contribute to achieving the organization's objectives, but besides their comprehensive use, it is necessary to choose them in accordance to the quality management concept in an organization [25]. The quality instruments are complementary, so the choice of the right sequence of these instruments allows solving the problems in an effective manner and enables continuous improvement of the quality [11, 20].

In the case of the problem identified in the company producing the furniture and furniture fronts, which

involved a lot of mechanical damage to the furniture fronts, the set of four quality management tools were used, i.e. 5W2H method, Pareto-Lorenz diagram, Ishikawa diagram and 5Why method. In the article, the sequence of these quality management tools is described and how it enabled to identify the potential causes, the main causes and the root cause of the problem, which was the lack of management knowledge and awareness of the need to implement visualization principles in the company. The improvement actions were proposed, thanks to which it is possible to eliminate or reduce the number of the mechanical damage occurrences in the furniture fronts.

2. Characteristics of selected quality management instruments

The analysis of the problem of mechanical damage to the furniture fronts was made using the sequence of selected quality management instruments, i.e. 5W2H method, Pareto-Lorenz diagram, Ishikawa diagram and 5Why method.

The 5W2H method consisted in asking seven questions, thanks to which it was possible to gather the most important information about the cause of the problem (Fig. 1).

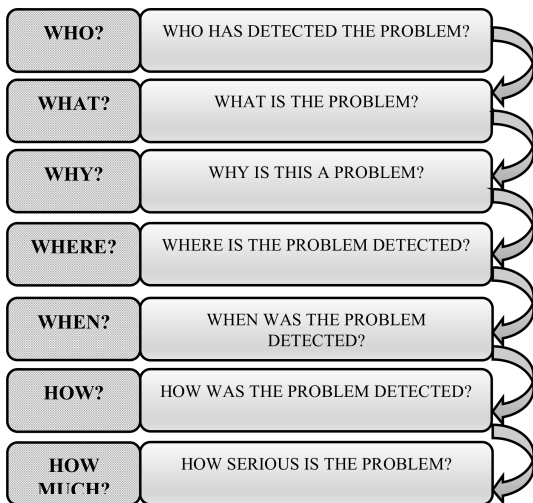


Fig. 1. The scheme of the procedure to use the 5W2H method. Own study.

The 5W2H method could always be used when it is necessary to obtain additional help in solving the problem [4].

The Pareto-Lorenz diagram is also called the Pareto-Lorenz analysis and the Pareto-Lorenz chart or the 80/20 method. It was made by Vilfredo Pareto in 1887 to analyse the distribution of income of the population [7, 26]. According to the 80/20 rule, this diagram is used in order to show the area on which to focus. With use the 80/20 rule it will be possible to improve the quality and effectiveness of management as it is assumed that 80% problems are generated by 20% causes [18, 19]. The selected ratio can be different and it should be selected according to the needs of the problem, however, it is important to remember that a relatively small number of causes generates a big number of the problems [9, 10]. This diagram allows arranging the factors, which have the most important influence on the problem, so it helps to make the right decisions and achieve the desired effects [24]. This tool is used to for example to analyse the quality problems [17, 19, 24] and financial management [12] or in material management [17].

The Ishikawa diagram is called the cause-and-effect diagram or the fish bone diagram. This diagram is used to analyse the potential causes of the problem. The essence of creating this diagram is based on showing in a graphic way the analysis of relationship between the causes of the problem [5, 15]. The Ishikawa diagram allows preparing in an orderly way the information about the problem, achieve the accuracy of the analysis resulting from teamwork and identify and eliminate the cause of a problem [21]. The basic category of the Ishikawa diagram are man, method, machine, management, measure and environment, which reflects the 5M+E rule [22]. These categories can be different from these, and everything depends on the problem which is analysed [23].

The 5Why method, the so called Why-Why diagram, is applied in order to identify the root cause of the problem or/and their graphic presentation, when the

others methods were not effective [17]. In this method, the main problem should be defined and then it is necessary for each of the main cause to ask the “why?” question. Each statement (the answer to the “why?” question) is the next level to another “why?” question. The method should be continued until the answer is exhausted and the root cause of the problem is found out [5, 20].

3. Methodology

In the company producing the furniture and furniture fronts from January to September, 285 pieces of the mechanically damaged products were identified (Fig. 2).



Fig. 2. An example of mechanical damage to the furniture front.

The boards used for the production the furniture fronts were the MDF (Medium Density Fibreboard) made of the wood fibres. The thickness of the board was between 12 mm and 19 mm, the bending strength was 20 N/mm² and the tear strength was 0.55 N/mm².

Due to the lack of the identified causes of the incompatibilities, the problem of the mechanical damage to the furniture fronts was analysed with the sequence of the selected quality management instruments. In the first stage, for the causes of the mechanical damage on the furniture fronts, the 5W2H method was used. The 5W2H method was used in order to characterize the problem. The method consisted in asking the seven questions thanks to which it was possible to collect the most important information about the causes of the mechanical damage. Due to the large number of responses, the questions and their answers were presented in a summary table so as to present the most important information about the problem in a transparent way [5, 20].

After characterization of the problem by means of the 5W2H method, the Pareto-Lorenz diagram was made, which is also called the Pareto-Lorenz analysis or the 80/20 method. The purpose of the Pareto-Lorenz diagram was to analyse what types of the mechanically damaged fronts constituted 80% of all the mechanically damaged fronts, and thus represented 20% of all the causes of incompatibilities [7, 8, 13, 18, 19].

The analysis of the problem using the Pareto-Lorenz diagram was made according to the generally accepted sequence of actions:

- the information about the problem of the mechanical damage to the furniture fronts was taken from the observation sheet from the analysed period of time (i.e. from January to September 2018),
- the most important data were selected in terms of the problem analysed, i.e.: the date of the failure, the mechanically damaged front, the number of mechanically damaged fronts,
- the Pareto chart was made, where along the horizontal axis on the rectangular coordinate graph, the type of the front and the number of mechanical damages were specified depending on the type of the front,
- the Lorenz curve (the graph of the cumulative values) was prepared, combining the points of successively accumulated shares of the identified causes,
- the graph according to the 80/20 rule was analysed in order to selected types of the fronts that generate a significant number of all mechanical damages,
- the measures have been taken to eliminate or reduce the mechanical damage [19, 21, 23].

In the next stage of the analysis the Ishikawa diagram was prepared. The Ishikawa diagram was made to identify the potential causes of the mechanical damage of the furniture fronts. In the fish head the problem was named (the mechanical damage on the furniture fronts). Next, in order to the analyse the problem, the basic categories of the Ishikawa diagram were selected (i.e. the 5M+E rule, like man, method, material, management, machine and environment) and a new category was added i.e. the cash resources. The new category was added because it was considered important when analysing this problem. The potential causes of the problem were assigned to these categories [5, 6, 21]. From the indicated potential causes of the mechanical damage to the fronts, the main causes were selected, so it was possible to made the further analysis to identify

the root cause [23, 27].

The 5 Why method was used to identify the root cause of the occurrence of the mechanical damage of the furniture front. The question “why” was asked until the answer was obtained, based on which it was possible to take the specific improvement actions [1, 2, 14].

The sequence of the selected quality management instruments to analyse the causes of the mechanical damage is shown in Fig. 3.

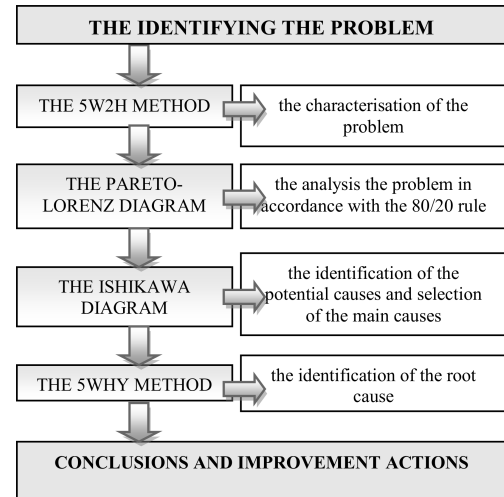


Fig. 3. The example of the sequence of the selected quality management instruments. Own study.

After the identification of the root cause the improvement actions were proposed in order to eliminate or decrease the occurrence of the mechanical damage to the furniture fronts.

4. Results

In order to characterize the most important information about the analysed problem and present the problem in a transparent form, the 5W2H method was used (Table 1).

Table 1
The extensive 5W2H method for the problem of the mechanical damage to the furniture fronts. Own study.

Question		Answer
Who detected the problem?	1	the operator of the milling machine
	2	the worker who was cleaning the fronts
	3	the employee from the Quality Control Department
What is the problem?		the mechanical damage of the furniture fronts
Why is this a problem?		the product incompatibility causing inability to sell and waste of the company resources
Where is the problem detected?	1	during production
	2	during production
	3	during the work control of the employees on one shift of the work
When was the problem detected?	1	during production
	2	during production
	3	during the work control of the employees on one shift of the work
How was the problem detected?		visual control
How many pieces are defective?		285 (the sum of non-compliant pieces in 9 months in 2018)
where the question and answer number are the same (i.e. 1-1, 2-2, 3-3)		

2), which were necessary to prepare the Pareto-Lorenzo chart (Fig. 4).

Table 2
The fragment of the table with calculated values for the Pareto-Lorenzo chart. Own study.

No.	The type of the front	The number of the mechanically damaged fronts	% share of the number of mechanically damaged fronts	% cumulative number of mechanically damaged fronts
1	K549	33	12%	12%
2	K501	32	11%	23%
3	K500	31	11%	34%
4	K900	25	9%	42%
...
22	K249	3	1%	79%
23	K502	3	1%	80%
24	K553	3	1%	81%
25	K905	3	1%	82%
26	K165	2	1%	83%
27	K254	2	1%	84%
28	K507	2	1%	85%
29	K511	2	1%	85%
...
64	K94	1	0%	100%
SUM		285		

It was concluded that the problem was detected by the three different staff members, i.e. the operator of the milling machine, the worker who was cleaning the fronts and an employee from the Quality Control Department. The problem of mechanical damage to the furniture fronts caused that the products were incompatible, which resulted in the inability to sell, and thus the waste of the company’s resources. The incompatible product was identified by the visual control during production or during the work control of the employees on one shift of the work. The problem of the mechanical damage to the furniture fronts concerned 285 pieces of the fronts recorded during 9 months in 2018.

In order to analyse on which types of the furniture fronts there was the greatest number of the mechanical defects, the percentage of the mechanical damage and the cumulative number of the mechanically damaged fronts were calculated (Table

Based on the table data and the Pareto-Lorenz chart, it was concluded that the first 8 types of the fronts constituted 80% of the entire number of front types.

For the purpose of identification of the potential causes of mechanical damage to the furniture fronts the Ishikawa diagram was prepared (Fig. 5).

After analysis of the potential causes of the mechanical damage to the furniture fronts the main causes were selected, i.e.:

- no warning lines about the storage location of the furniture fronts – both when they were stored by the employee immediately after being pulled out of the milling machine and in the warehouse,
- no warning sign to other employees about the storage location of the furniture fronts,
- the storage of the furniture fronts near the passage of the transport vehicles e.g. the forklifts.

In order to identify the root cause of the problem of the mechanical damage to the furniture fronts the analysis by the 5Why method was made (Fig. 6).

The 5Why method made it possible to identify the root cause of the occurrence of the mechanical damage to the furniture fronts. It was concluded that the root cause was the lack of the management knowledge and awareness of the need to implement visualization principles in the company.

It was concluded that the lack of the warning lines on the production hall and on the storage area (the warehouse) meant that the workers did not have a designated fixed area to which they should put the furniture fronts. In turn, the lack of warning signs, e.g. in front of the fronts storage area, meant that the employees did not pay attention to the manufactured products

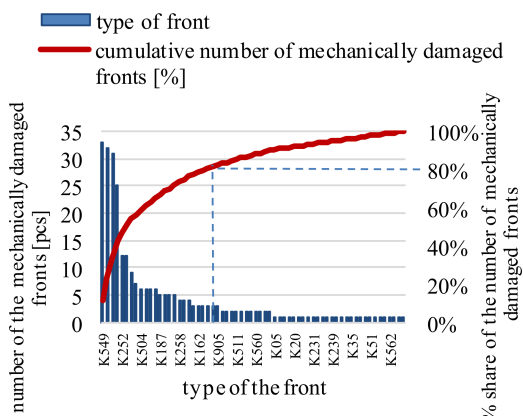


Fig. 4. The Pareto-Lorenz chart for the problem of the mechanical damage furniture fronts. Own study.

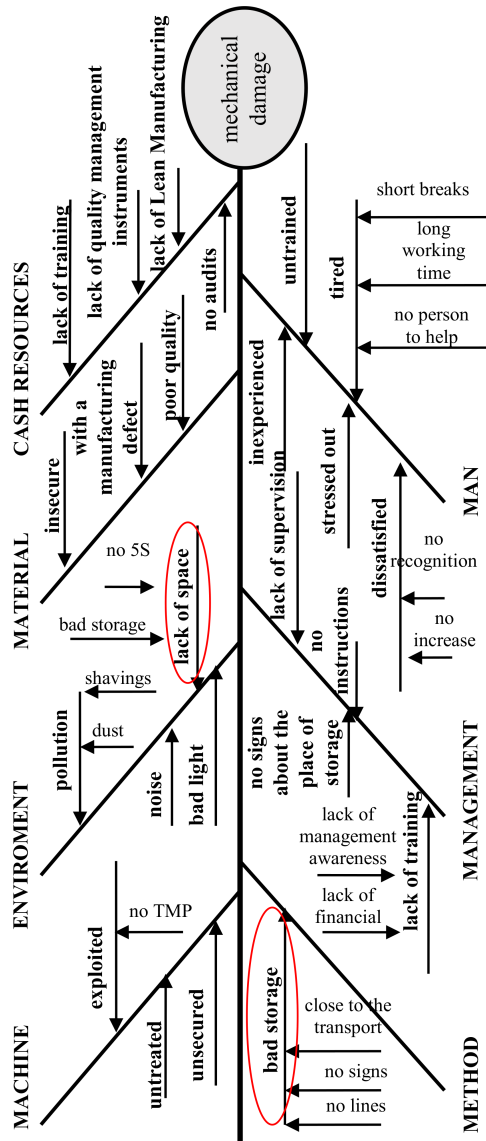


Fig. 5. The Ishikawa diagram for the problem of the mechanical damage to the furniture fronts. Own study.

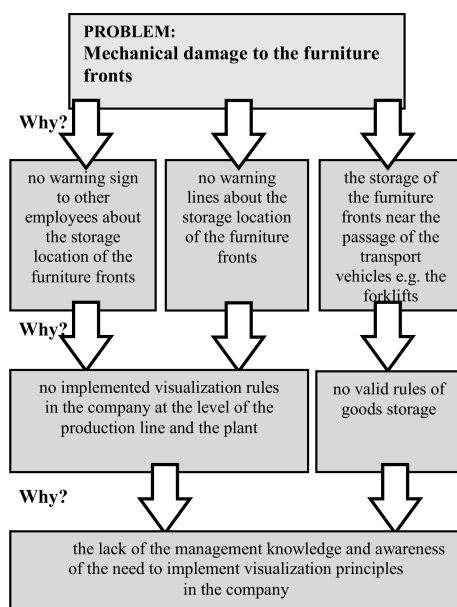


Fig. 6. The 5Why method for the problem of the mechanical damage to the furniture fronts. Own study.

which were often damaged by them. Another reason for the mechanical damage of the furniture fronts was the storage of furniture fronts near the passage of the transport vehicles, such as forklifts.

5. Conclusion

The applied sequence of quality management instruments, i.e. the 5W2H method, the Pareto-Lorenz diagram, the Ishikawa diagram, and the 5Why diagram, made it possible to identify the root cause of the mechanical damage to the fronts and furniture. It was concluded that the root cause was the lack of the management knowledge and awareness of the need to implement visualization principles in the company. Identification of the root cause made it possible to propose appropriate improvement actions, thanks to which it was possible to eliminate or minimize mechanical damage on the fronts and furniture.

It was concluded that implementation of the information boards and lines in the areas and storage locations of the furniture fronts would be a simple way to identify the storage locations and prevent the mechanical damage of the furniture fronts. The employees would place the products in the designated areas so it would be possible to eliminate the cause of the mechanical damage resulting from the devices and machines like the forklifts. These actions would allow eliminating or significantly reducing the number of the mechanical damage to the furniture fronts, and introducing labour standards that would contribute to improving the functioning of the entire enterprise. In addition, the introduction of visualization rules at the level of the production line and plant would help keep order as well as enable a quick assessment of the production stage. The analysis and the proposed improvement actions may be applied in other companies from both the production and service sectors.

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