

ANALYSIS OF THE CAUSES OF INCOMPATIBILITIES IN THE SELECTED PRODUCTION PROCESSES

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Abstract: Analysis of the incompatibilities occurring in an organization relies on identifying the problem and then applying the appropriate corrective and improvement actions. It is possible by using appropriate instruments of quality management and, basically, their sequence, which is a modern way of solving the problem, and it enables the improvement of functioning of an enterprise. Therefore, it is advisable to select an appropriate group of quality management instruments and use them in the appropriate sequence, because then they are complete and lead to full analysis and conclusions adequate to the problem. The aim of the article is to analyze the correlation and influence of the selected factors on the incompatibilities in selected processes, i.e. the production process of furniture fronts and furniture in general. Moreover, the idea is to use the appropriate sequence of instruments of quality management to solve various types of incompatibilities. The analysis was made at a company where a lot of different kinds of incompatibilities in processes were identified within 9 months. It was important to solve the problem for this enterprise because it was generating relatively large financial losses, and the lack of identified causes of the problem precluded taking preventive actions and developing the enterprise. After the initial analysis of the processes and problems, it was decided to use the correlation analysis, the Pareto-Lorenz diagram, the 5W2H method, the Ishikawa diagram and the 5Why method. The methodology and conclusions drawn from the analysis may be useful in solving complex problems at other production and service enterprises.

Keywords: production process, quality management, incompatibilities, the Ishikawa diagram.

1. Introduction

By using quality management tools, it is possible to analyze the problems that arise in every company. It is important to analyze a problem correctly and then draw constructive conclusions, thus making decisions on the implementation of the improvement measures which will be effective if the analysis of the causes of the problem is carried out in an appropriate manner. The term quality refers to a set of features of a given product or service, thanks to which it is possible to ensure customer satisfaction. If enterprises want to meet customer requirements, they have to produce products that are good in terms of quality and compatible with the requirements of the customers. The strive to satisfy customer requirements and produce the best quality products results from the company goal, which depends, among others, on enrichment (i.e. increasing revenue) and lack of waste. The detection of the causes of incompatibilities and their effective elimination is the basis for ensuring high quality of products and maintaining production continuity.

The problem with incompatibilities was identified in an enterprise located in the Subcrpathian Voivodeship, the activity of which included the production of furniture fronts and furniture. Approximately 7,000 different types of incompatibilities occurred in the enterprise within 9 months, and the lack of an identified main cause of the problem implied that it was impossible to take preventive actions. The aim of the article is to analyze the correlation and influence of the selected factors of incompatibilities of furniture fronts and furniture and to propose the use of the appropriate sequence of quality management instruments to solve the incompatibilities. Data regarding the number of incompatibilities occurring in the enterprise from January to September 2018 were analyzed. Due to a large amount of the data, as well as a large amount of the causes of incompatibilities, the applied sequence of instruments of quality management was proposed. Additionally, the importance of the correlation analysis for this problem was shown.

The STATISTICA program was used to analyze the correlation between the type of the incompatibility and other factors describing their occurrence, i.e.: date, number of the plan, product surface, color, product profile and type. In order to graphically present the number of incompatibility types and the incompatibilities comprising 80% of effects and generated by 20% of the causes, the Pareto-Lorenz diagram was made. Then, according to the methodology of the 5W2H method, an expanded graphical characteristic of the problem was made. In order to identify the potential causes of the problem, the Ishikawa diagram was made. The diagram was extended by additional factors which were correlated with the analyzed incompatibilities. In the last stage of the analysis, the 5Why method was used to identify the root cause of the incompatibility of furniture fronts and furniture. It was concluded that the reason was small (or the lack of) participation of employees and the management in conferences or trainings

regarding the optimization of the hall, machine maintenance (TPM), i.e. the topic of Lean Manufacturing and quality management.

2. Materials and methods

Due to the lack of identified causes of incompatibility (Figure 1), an appropriate sequence of quality management instruments was used in the analysis. In addition, the correlation analysis was conducted using the STATISTICA program.

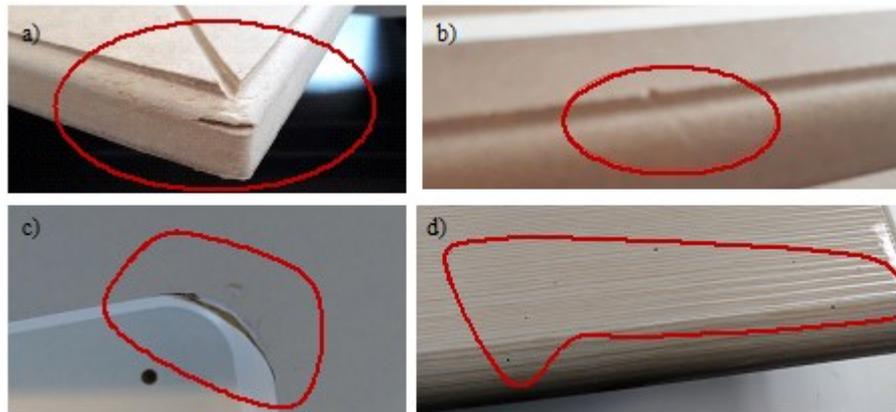


Figure 1. Examples of selected incompatibilities: a), b) mechanical damage, c) foil damage, d) stains.

In the first step of the analysis, the Pareto-Lorenz diagram was made in order to identify, according to the 80:20 rule, which of the 80% of effects are caused by 20% of causes (Arvanitoyannis, and Savelides, 2007; Arvanitoyannis, and Varzakas, 2007; Hartman, 2001). Before the Pareto-Lorenz diagram was made it was necessary to prepare data regarding the incompatibilities (Hoła et. al., 2017; Hola et. al., 2018). The data was arranged in the descending order and the cumulative number of the types of encountered incompatibilities and their cumulative percentage were calculated.

The STATISTICA program was used to analyze the correlation between the types of incompatibilities and other factors describing their occurrence, i.e.: date, number of the plan, product surface, color, product profile and product type. The data concerning the problem were entered into the computer program and text labels were provided to the values which were not numerical. The confidence allocation of 0.95 was selected, which implied that the correlation between the factors occurred in the case of the significance level of 0.05.

In order to identify the potential causes of the problem of incompatibilities of furniture fronts and furniture, the expanded Ishikawa diagram was made; it is also called the fish bone diagram or the diagram of causes and effects of defects. The elements which were necessary to prepare the Ishikawa diagram were the areas with which the causes of the problem were matched. Elements such as: method, material, environment, man, management and machine – 5M+E (Bilsel, and Lin, 2012; Chokkalingam et. al., 2017; Lira et. al., 2017) were added to those

areas. Only a few categories, namely: man, machine, management and environment were selected to analyze this problem because it was thought that only those categories were related to the problem analyzed. However, as a follow-up, additional categories correlated with the problem were identified, i.e.: date, color, product profile and product type (Pacana et. al., 2018a, 2019b).

The 5W2H method was used to define and diagnose as well as present the characteristics of the problem in a simple and understandable way. The 5W2H method was based on asking seven specific questions referring to the problem analyzed (the incompatibilities of the fronts and furniture), i.e.:

- Who? – Who noticed a problem?
- What? – What was the problem?
- Why? – Why was it a problem?
- Where? – Where was the problem noticed?
- When? – When was the problem noticed?
- How? – How was the problem noticed?
- How much? – How big was the problem?

The questions that were asked during the analysis using the 5W2H method were of variable nature (Klock et. al, 2016; Nagyova et. al., 2015; Salvador, and Goldfarb, 2004; Shin, 2015). The 5Why method enabled a gradual analysis of the problem of incompatibilities of the fronts and furniture, thanks to which the source of the problem was identified (Benjamin et. al., 2015; Braglia et. al., 2017; Lindhard, 2014).

3. Results

In the first stage of the analysis of the incompatibilities of furniture fronts and furniture, the Pareto-Lorenzo diagram was drawn up (Figure 2). The data shown in the diagram refer to all nonconformities identified from January to October 2018 in the production enterprise where the analysis was carried out.

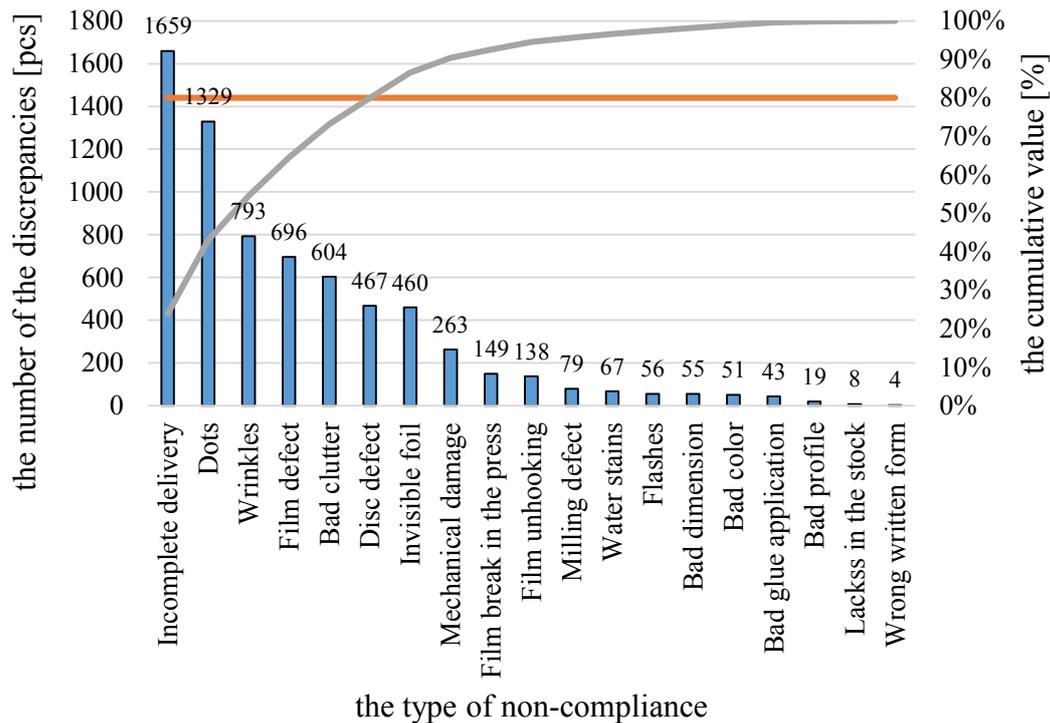


Figure 2. The Pareto-Lorenz diagram for all discrepancies identified from January to October 2018 in the enterprise producing furniture fronts and furniture.

It was concluded that 20% of incompatibilities, i.e.: incomplete delivery, dots, wrinkles, foil defects, holes and defects, were generating 80% of the reasons for the identified incompatibilities.

An analysis of the correlation (Figure 3) between the type of incompatibility and the factors characterizing each of the analyzed types of incompatibilities was conducted; these included: date, plan number, product surface, front color, furniture profile and type of the product. After the analysis, it was concluded that there was a correlation (so the level of significance was lower than 0.05) between the type of the non-compliance and, in turn, the date of non-compliance, front color, furniture profile, type of the product.

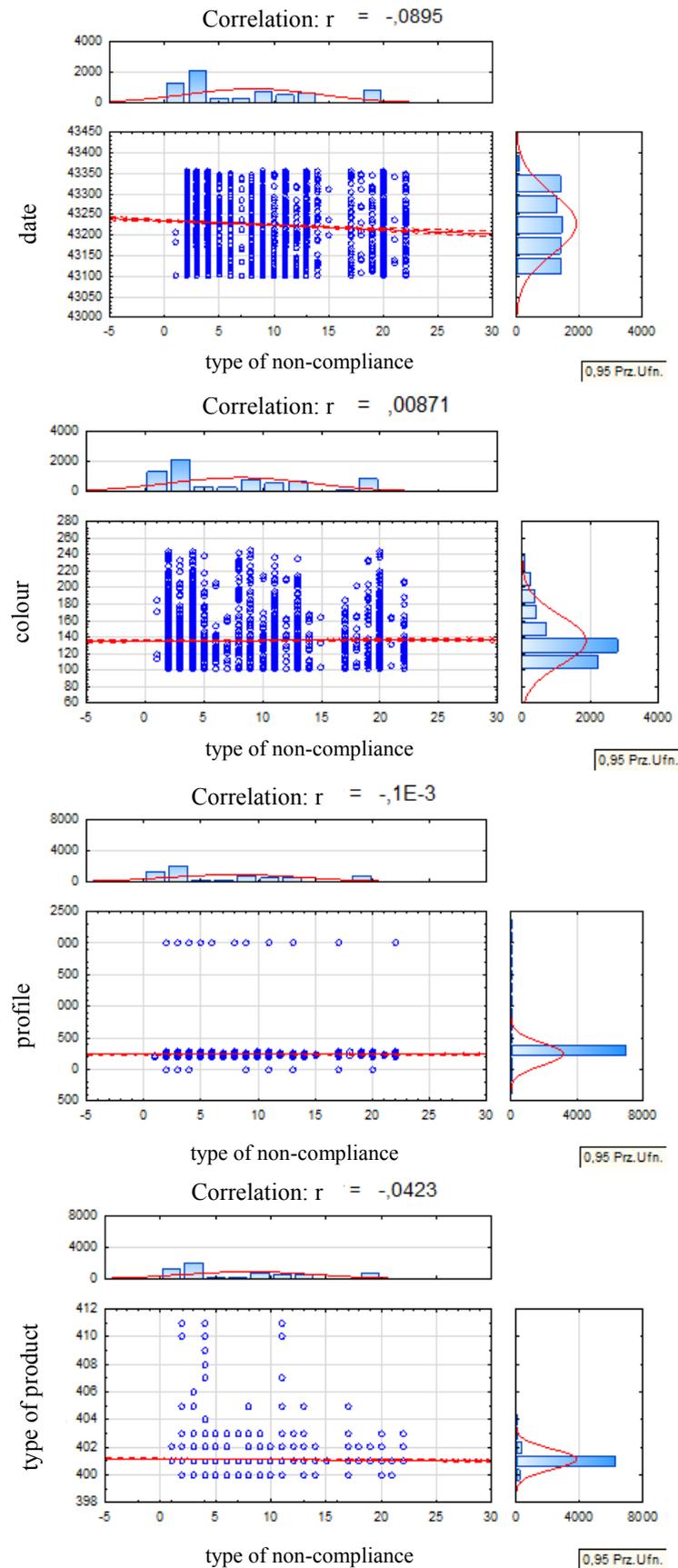


Figure 3. Correlations between the type of incompatibility and: a) date, b) color of the furniture front, c) furniture profile, d) type of the product.

In order to characterize the problem of incompatibilities of furniture fronts and furniture, the data concerning the problem were analyzed and the scheme was developed in accordance with the 5W2H methodology (Figure 4).

It was concluded that the problems arose mainly at the production stage on various production machines, as well as during the inspection of the products in the course of production and in the warehouse. The incompatibilities caused many problems which prevented the development and growth of the company's profits.

In order to identify the potential causes of the problem of incompatibilities of fronts and furniture, an extensive Ishikawa diagram was prepared, in which additional factors were included in addition to the basic factors which were correlated with the type of the incompatibility (Figure 5).

It was concluded that the main reasons for incompatibilities of fronts and furniture were: poor storage, pollution, worn out machinery, season, poorly taped products, varied shape and manufacturing defect of the product. In order to identify the source cause of the problem, selected main reasons that were found to be related to 20% of the incompatibilities (previously identified in the Pareto-Lorenz analysis) were analyzed using the 5Why method (Figure 6).

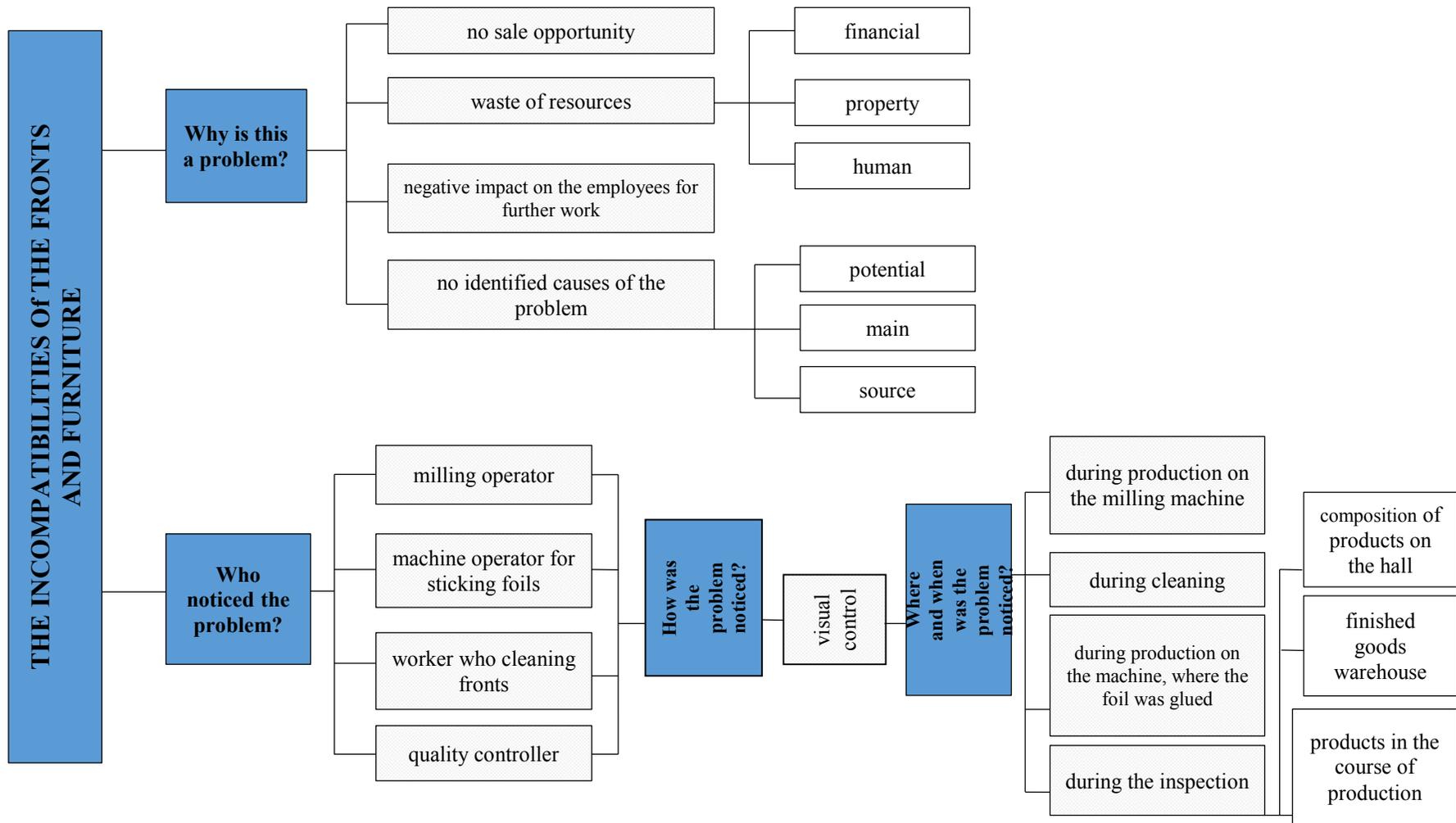


Figure. 4. The graphical 5W2H method for the problem of incompatibilities of the fronts and furniture.

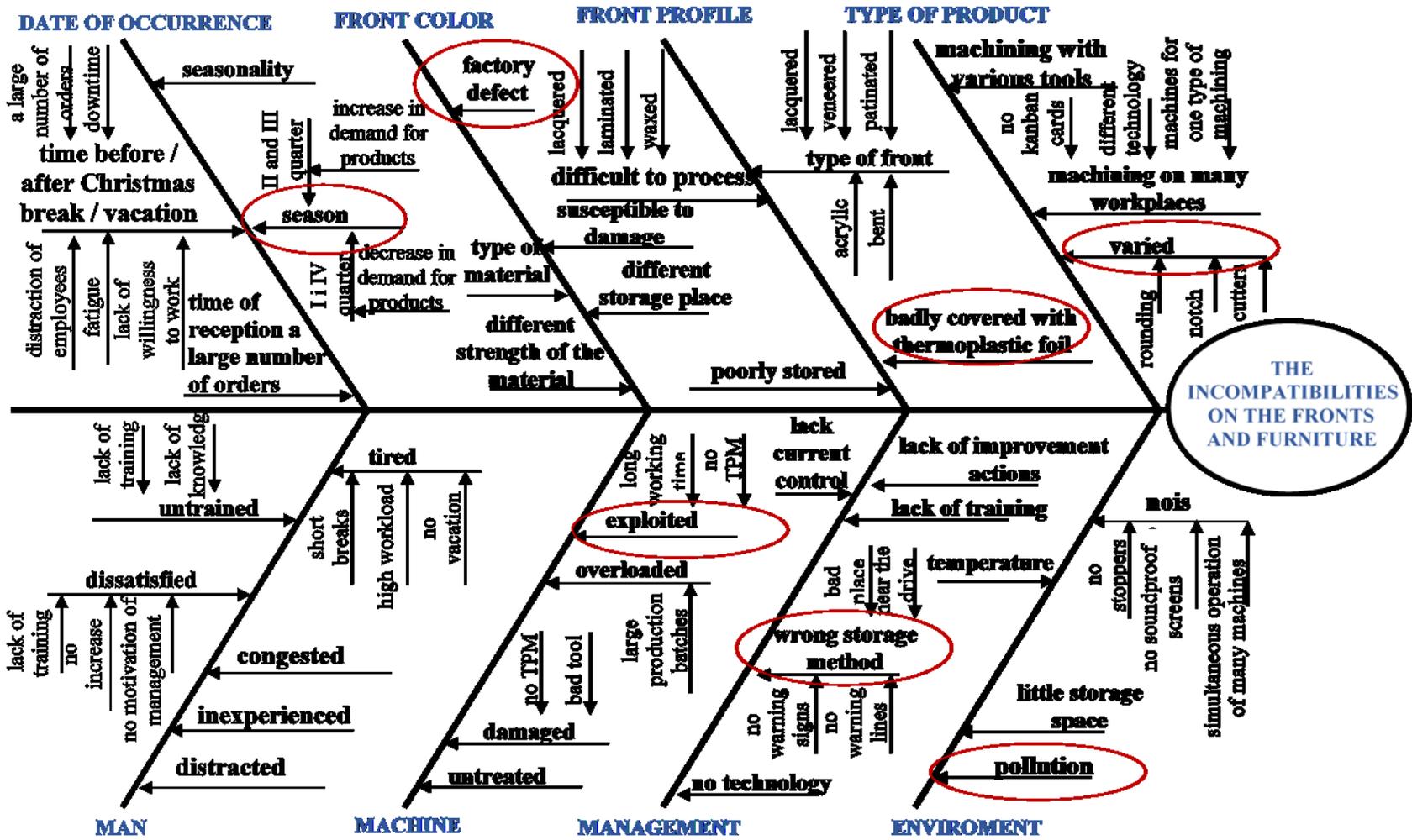


Figure 5. The Ishikawa diagram for the potential causes of the incompatibilities of the fronts and furniture.

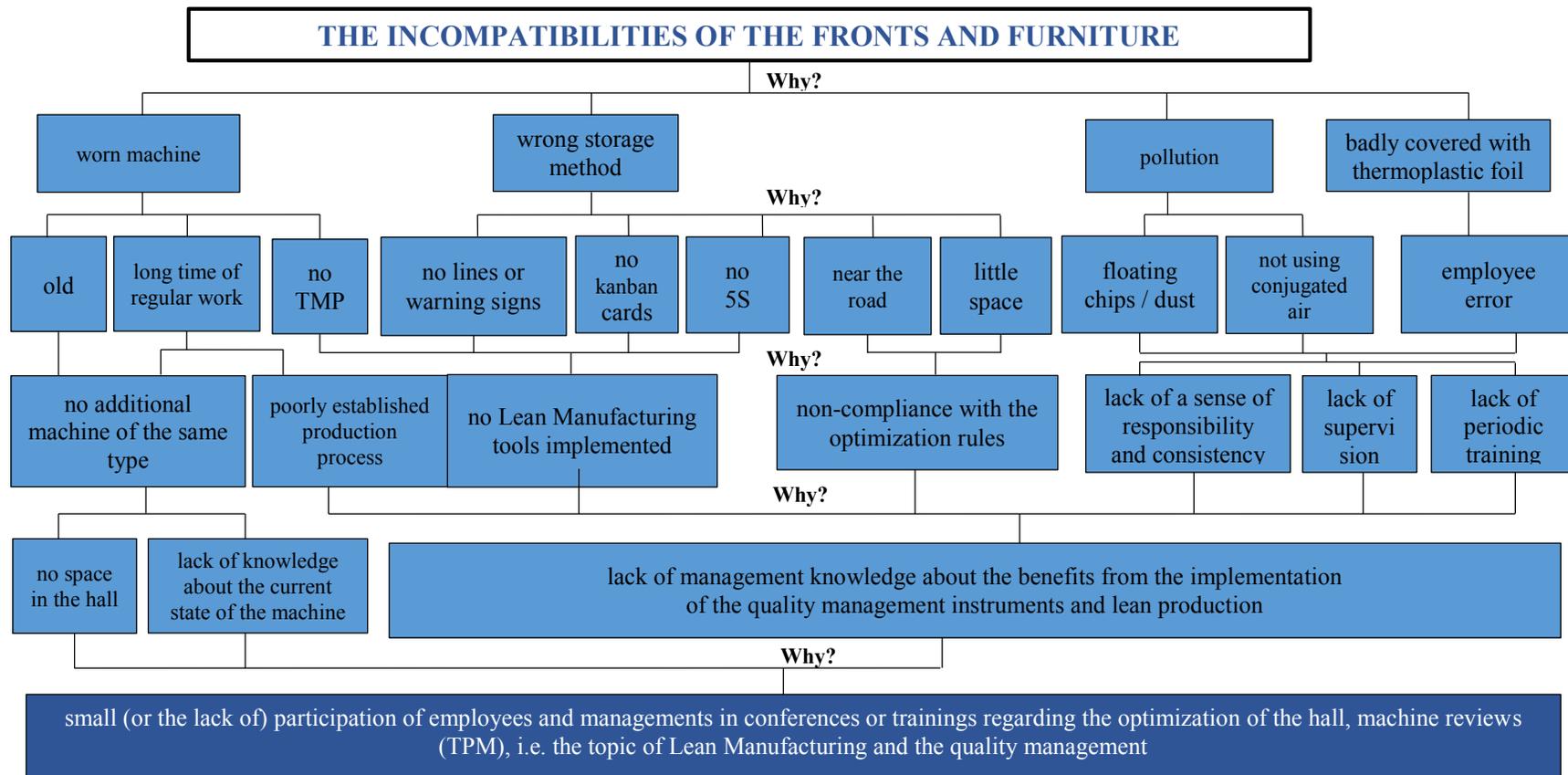


Figure 6. Analysis of the problem using the 5Why method for selected potential reasons for the occurrence of the problem.

After the analysis of the problem, the source cause of the incompatibilities of fronts and furniture was found. The source cause was small (or the lack of) participation of employees and management in conferences or trainings regarding the optimization of the hall, machine maintenance (TPM), i.e. the topic of Lean Manufacturing and quality management.

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