



Increasing the Efficiency of Furniture Production – Case Study

Anna KARWASZ , Paulina REWERS , Adrianna CHRZANOWSKA, Natalia CHWACIŃSKA

Poznan University of Technology, Poznan, Poland

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Abstract

The article presents the possibility of increasing the production efficiency in an enterprise dealing in the production of lounge furniture. The literature review shows that Poland is the sixth country in the world in the amount of furniture production. It is also one of the leading exporters of upholstered furniture in Europe. Each year, the value of furniture sales production increases by a few percentage points. Due to the constantly growing customer orders, many companies in this industry are struggling with delays in delivering products to customers. This problem also occurs in the analyzed company. While analyzing the production process, the occurrence of a large number of non-conformities was also noticed. An analysis was carried out to indicate the number of non-conformities and the place of their occurrence. The FMEA analysis was used, which indicated which non-conformities are the most important, and the 5Why method, which allowed to indicate the cause of their occurrence. The analysis of production processes showed which activities do not bring added value and how they can be eliminated at no cost. All these measures contributed to increasing the efficiency of the production of lounge furniture.

Keywords

Production efficiency; Lean manufacturing; Six Sigma; 5 WHY method; FMEA.

Introduction

Enterprises of the 21st century face many challenges. The most important of them are the acquisition of new knowledge and continuous improvement in order to best meet customer expectations and ensure safe working conditions (Żywicki & Rewers, 2020; Marksberry, 2010; Purba et al., 2021). Today's technical progress forces entrepreneurs to constantly modernize production processes and customize products. That is why it is so important to improve production processes, thanks to which their efficiency is increased (Kiyatkina et al., 2014).

One of the modern production management concepts is Lean Manufacturing (Rewers et al., 2019; Naveen et al., 2014). The goal of Lean is to eliminate all waste occurring in production. The tools and methods included in the Lean concept support the company in improving its processes. One of the most commonly used methods is the 5S method (Leksic

et al., 2020; Sharma & Lata, 2018). This method is considered an excellent start to introduce the whole concept in the company. However, simply operating according to Lean Manufacturing principles is often not enough. That is why many scientists and practitioners believe that Six Sigma is the perfect complement to Lean. Six Sigma is a concept of continuous improvement of the organization, consisting in monitoring and continuous control in order to eliminate and prevent various inconsistencies in processes and resulting products. The tools used in Six Sigma include: for the analysis of the causes of problems are, for example, the Ishikawa diagram, the 5Why method, or the FMEA analysis (Sarman & Soediantono, 2022; Pugna et al., 2016; Niñerola et al., 2021).

Literature review

Most companies in the furniture industry, especially small and medium-sized companies, use a simple approach to improving or managing production processes. The article (Šimanová & Sujová, 2022) presents the results of research aimed at continuous improvement through the implementation of the Lean Six Sigma concept in furniture production. The results indicate that furniture companies that have

Corresponding author: Anna Karwasz – Poznan University of Technology, Piotrowo 3 Street, Poznan, Poland, 61-138, phone: +48 61 665 27 74, e-mail: anna.karwasz@put.poznan.pl

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implemented selected quality management methods achieve an average level of ROE (Return on Equity). A thorough analysis of non-conforming products carried out in furniture production processes and the implementation of a model based on LSS led to a reduction in process waste by reducing the number of non-conforming products, reducing the cost of these products, and increasing the capacity of critical processes. Also, another author (Suhardi et al., 2015) indicates that the implementation of SMED and standardized work in a company from the furniture industry allowed to shorten the delay in delivery time. In turn, the article (Guerrero et al., 2017) presents the implementation of LSS in a small furniture company, thanks to which the number of quality errors was reduced by 25%, the amount of waste by 13%, and productivity increased by 14%. The above mental analysis shows that the implementation of LSS in the furniture industry can increase efficiency, also reducing the number of quality errors.

The furniture industry in Poland ranks fifth in terms of sales among branches of Polish industry (Grzegorzewska, 2019). There are over 26,000 enterprises in the furniture industry, employing over 151,000 people, which makes this market one of the largest employers in Poland (KPMG, 2021). Upholstered furniture is an important part of the furniture market, and the value of export increases dynamically every year (Furniture business, 2021). In order to increase the competitiveness of these enterprises on domestic and foreign markets, it is necessary to support their development, using available methods of streamlining and improving production processes.

The article presents the results of research on increasing the efficiency of the production of leisure furniture in a medium-sized family manufacturing company. A number of studies were carried out to identify the main cause of delays in product deliveries to the customer due to low efficiency. The research was carried out in the upholstery and cutting department. The tests were carried out over several months during normal continuous production. It was shown that it is possible without the contribution of financial resources to increase work efficiency in a given position or department.

Materials and methods

Current state

The analyzed enterprise is a family business that was established in the early 2000s and employed 10 employees working on a 500m² production hall.

Currently, the production area is 2400m² and the company employs about 100 people. The company produces armchairs, corner sofas, sofas, couches and pouffes. Raw materials such as fabrics, wooden decorative elements, etc. are used for their production.

The company produces five days a week, in a one-shift system. Production is planned based on customer orders. Based on the dates of their arrival and expected delivery, the production schedule is arranged two weeks in advance of the start of production. The company was struggling with delays in fulfilling customer orders and errors in production for some time. Since the company is not large and does not have large financial resources to purchase new equipment or new technology, it decided to make improvements that do not require a financial contribution and only focus on a possible reorganization of production.

Manufacturing upholstered furniture is a process that consists of several interrelated stages. On the basis of the system shown by Navratil [18], a block diagram of a model process for the production of upholstered furniture was developed, Figure 1.

The next steps in the process include the following activities (Rosova et al., 2022):

1. Fabric inspection, preparation of pattern plans, preparation of other materials, i.e. springs, etc.
2. Laying and distribution of upholstery materials and arrangement of springs.
3. Installation of springs and joining other details into groups, e.g. gluing foam to the frame, preparation of other foams, etc.
4. Milling, drilling, gluing components into their final shape.
5. Sewing the cover to cover the product, gluing the details, stapling the cover to the furniture structure.
6. Decorative sewing, stitching, stretching, etc.
7. Inspection of the finished furniture, completion and packaging, etc.

The course of processes in various enterprises may differ in the sequence of performing individual activities, however, the goal of each producer is to make products in the shortest possible time, with the least amount of work, with maximum profit (Rosova et al., 2022).

The aim of the research was to eliminate delays in the execution of customer orders and to increase the efficiency of the production process. The work carried out concerned mainly: analysis of the causes of delays in the execution of orders, and then indication of the most common non-conformities, proposing actions to eliminate the causes of non-conformities, conducting improvements, estimating production efficiency before and after the proposed corrective actions. The

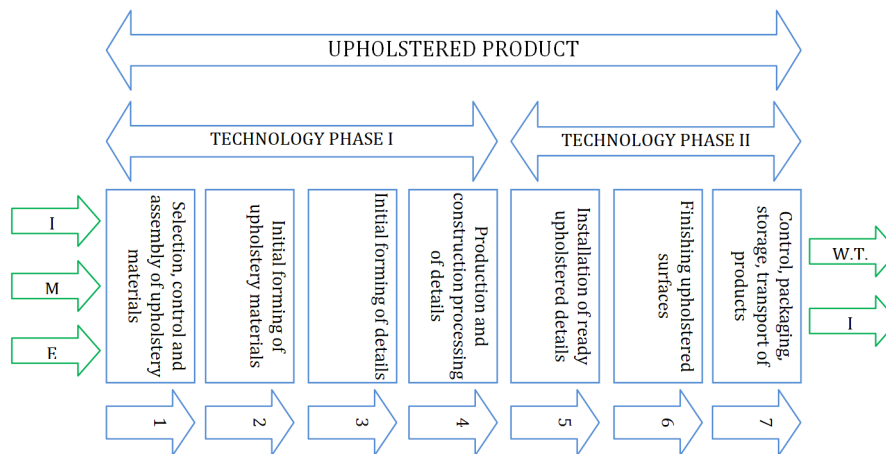


Fig. 1. Model of the production technology of upholstered products (Rosova et al., 2022).
 W.T. – upholstered product, M, E, I – material, energy, information about the upholstered product

research in the company lasted several months. The research was carried out in the course of the actual typical daily work of production workers.

Results and discussion

In the first phase of the analysis, the most common errors occurring during production in all departments of the company were identified. The data was taken from production reports from the period of 3 months, filled in by employees on each production shift. The results of the analysis are presented in Table 1.

Each of the above errors generated problems related to the next phase of processing, and also caused the need to redo the production, which meant that

the entire production order was delayed, and shipment to the customer was not possible in the assumed time. Due to this, the actual efficiency of individual departments was lower than assumed. Therefore, it was decided to take action leading to an analysis of the causes of the resulting non-conformities and their elimination.

The first action leading to the indication of the causes of non-compliance was the 5Why analysis, which was performed for all non-compliances listed in Table 1. The analysis was carried out by a team consisting of employees, managers and external specialists cooperating with the company in the field of improving production processes. After identifying the potential causes of non-compliance (shown in Table 2, in the “Cause” column), an FMEA analysis was per-

Table 1
 Errors occurring in the enterprise in the months of: February, March, April

Errors	February		March		April	
	number of detections	participation in production, %	number of detections	participation in production, %	number of detections	participation in production, %
Badly glued frame	18	2.4	21	2.8	17	2.3
Fabric shading	22	2.93	24	3.2	21	2.8
Poorly cut covers	73	9.73	76	10.13	72	9.6
Floating topstitching	24	3.2	23	3.07	22	2.9
Crooked cushion stitching	17	2.27	18	2.4	23	3.1
Shifted drilling grid	30	4.00	27	3.60	21	2.8
Insufficient/too light fabric	43	5.73	40	5.33	38	5.1
TOTAL	227	30	229	30.5	214	28.53

Table 2

FMEA analysis of the causes of errors in individual departments of the company, where: the importance of the error in terms of the effects it causes (C), the probability of the error or the cause of the error (R), the possibility of detecting the error (W)

Department	Errors	Effect	Cause	Z	R	W	WPR	Corrective actions
Cutting room	Fabric shading	Unaesthetic look of the pattern	Employee error	5	4	3	60	Advanced training for new employees
	Poorly cut covers	Unaesthetic appearance of the pattern; the need for corrections	Bad work organization in the department – workload	3	7	3	63	Reorganization of the division of duties among employees
Upholstery	Shifted drilling grid	Necessity to apply corrections	Employee distraction	3	6	3	54	Use of muffing earmuffs
	Insufficient/too tight fabric	Unaesthetic appearance of the final product	Unfavourable working conditions	4	6	2	48	The use of mute earmuffs
			Defective material	4	6	4	96	Increased quality control of material supplies

formed. Using the analysis, the effects of the above non-conformities were determined and potential corrective actions were proposed. The FMEA analysis is presented in Table 1.

After the FMEA analysis, the errors with the highest value of the CAP index were identified, which are: insufficient/too tight fabric (96), poorly cut covers (63), fabric shading (60) and a shifted drilling grid (54). In order to improve the operations in the cutting room, it was proposed to purchase a punching device that would reduce the number of bad patterns. However, this is associated with high purchase costs and would require investment by the owners of the company. In the upholstery department, a significant cause of errors is the inattention of employees, therefore appropriate corrective and preventive actions should be applied in order to reduce the occurrence of errors in the future. It is a good idea to know the causes of this problem. In the case of upholstery, no financial outlays are necessary with possible improvements to improve working conditions.

For the cutting room and upholstery department, it was also decided to analyze the activities performed by operators at the workplace and determine their times in order to determine whether the activities carried out may cause the employee’s distraction, and if so, what are these activities. Operations were also divided into adding value (VA), not adding value (NVA) and not adding value but necessary in the process (NNVA). Figure 2 shows the percentage share of individual times in the departments, broken down into

activities that bring added value and those that generate losses. In the upholstery department, 17% of the time is non-value-added, and in the cutting department, 16%.

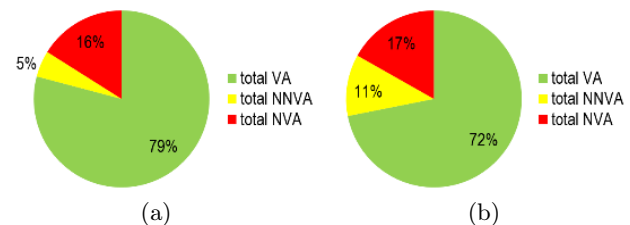


Fig. 2. Percentage of individual times in the section: (a) cutting room, (b) upholstery

Among the activities that do not add value, the largest part is the activity of searching for tools or other items necessary for the proper performance of a production operation. The second activity, which was also repeated frequently, is the transport of elements needed for production from the warehouse of raw materials.

Introducing improvements

The longest operation time, the lowest efficiency and the largest production of non-conforming products are found in the cutting room and upholstery department. In these places, employees are the least

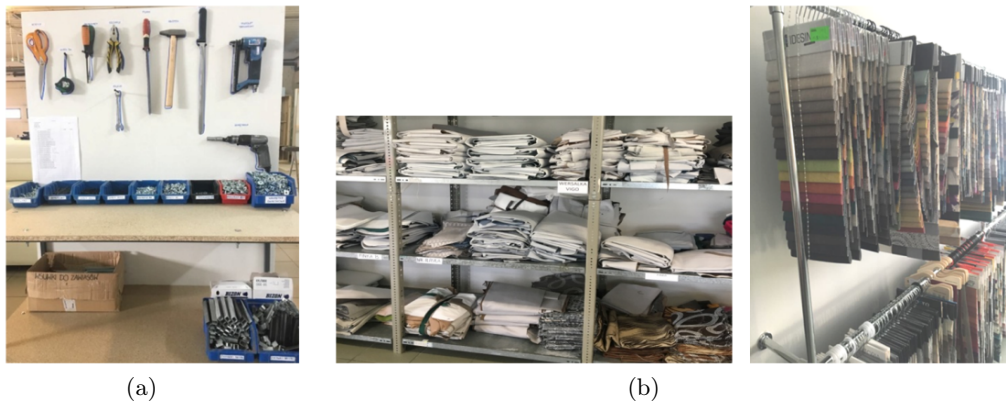


Fig. 3. Orderly workplaces, a) upholstery room, b) cutting room

productive, performing additional, unnecessary activities, such as repeatedly going to warehouses for materials and looking for tools at the workplace that can be avoided by changing the organization of the workplace. By shortening the duration of individual activities, with the same expenditure, it will be possible to produce more products, and thus increase efficiency.

In order to eliminate activities that do not add value, 5S was introduced in the upholstery and cutting room departments. The focus was on the selection of unnecessary items from the workplace, organizing the workplace, sorting materials into appropriate groups and introducing control audits. Figure 3 shows a workplace with 5S implemented.

After the introduction of 5S in the upholstery and cutting room departments, the duration of individual operations was again monitored. The durations of non-value adding but essential operations were significantly reduced, and non-value adding operations were completely eliminated. Figure 4 shows the percentage of individual times in the cutting room and upholstery department.

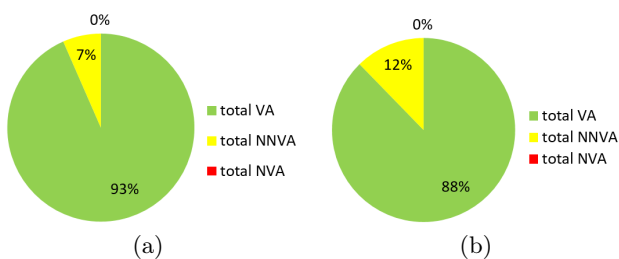


Fig. 4. Percentage of individual times in the section: (a) cutting room, (b) upholstery, after making changes

Considering the fact that employees work in a single-shift system for 7.5 hours a week, the following changes were observed:

Cutting room:

- before the introduction of 5S, the following products were produced: 12.06 products per day by one employee,
- after the introduction of 5S, the following products were produced: 14.11 products per day by one worker.

The efficiency of one employee of the cutting room increased by 16.99%, which resulted in an increase in weekly production by 10.21 pieces of products.

Upholstery:

- before the introduction of 5S, the production of: 11.66 products per day by one employee,
- after the introduction of 5S, the following products were produced: 14.22 products per day by one worker.

The productivity of one employee of the upholstery department increased by 21.96%, which resulted in an increase in weekly production by 12.8 items.

Additionally, a new hall layout was introduced in the upholstery department. Three separate, three-person sockets were proposed, including two upholsterers and one fitter, Figure 5.

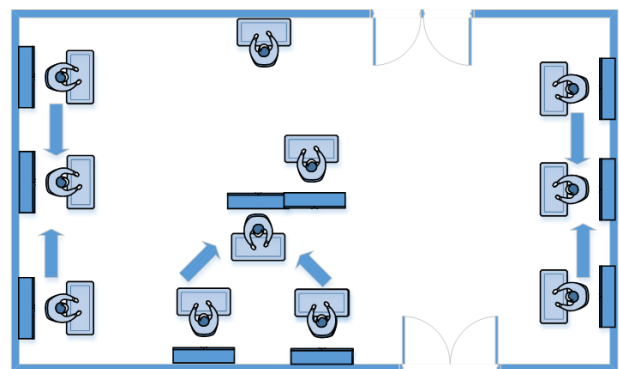


Fig. 5. Layout of the production hall after introducing improvements

The activities performed so far by one upholsterer were divided into two, where each of them produces individual elements of the product, and the fitter who combines the previously prepared elements. The activities were divided so that the working time of upholsterers in each of the teams was similar.

When changing the organization of work in the upholstery department, a number of advantages were noticed. One of them is more orderly workplaces that result from a smaller number of necessary tools for work. The order in the positions means that the time needed to perform individual auxiliary activities is shorter.

The last of the noticed benefits is the more efficient work of upholsterers, which results from more “automatic” activities. Fewer things to do also keep employees more focused on what they are doing and making fewer mistakes.

In addition, after the changes were made, the number of errors related to shifting the drilling grid and poorly stretched fabric was observed and measured. The first error was observed to remain at the level of April, i.e. 21, and the second decreased from 38 in April to 36 in May. After introducing the changes, the time was measured again, this time in the production cell. Then, the productivity for the production cell was calculated. Thanks to work in the production cell, the production of one corner takes on average 22 minutes. This means that one nest per day will produce 20 corners. Thus, the efficiency of one production cell is 96%, which increases the efficiency by about 20 percentage points. Thanks to the introduction of the work organization in the nest, an increase in efficiency to the level of 96% was recorded. This shows the success of the experiment. In addition to increasing productivity, a number of other benefits were noticed, such as a more organized workplace resulting from fewer necessary tools, fewer errors during production.

Conclusions

Continuous improvement of production processes is one of the most important aspects of enterprise development. Various tools and methods are used for its implementation, including the concept of Lean Management.

Improving the production process of lounge furniture began with its analysis. The Ishikawa diagram, FMEA and 5WHY methods were used. Errors in individual departments involved in the production process were identified and the reasons for their occurrence were discovered. It was noticed that chaos reigned in

the production hall while the work was being performed. Employees performed their assigned tasks, wasting a lot of time searching for the necessary materials and tools. It was caused by clutter and lack of organization of work stations. Based on the observations made, it was decided that the most appropriate way to get rid of the above-mentioned shortcomings would be the introduction of 5S. After the implementation of 5S, a reduction in operating times was observed, and thus also an increase in the efficiency of the company’s production process. In order for the introduction of 5S to be a success, it should be remembered that it is a long-term process in which the most important thing is to maintain the effects continuously.

The reorganization of work in the upholstery department also resulted in shortening the production time and thus increasing the efficiency of the leisure furniture production process.

Conducting studies and introducing improvements to production stations were performed during the daily work of both production and office workers. None of the introduced improvements required any financial outlays.

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