MANUFACTURING SYSTEMS IMPROVEMENT WITH 5S PRACTICES

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Abstract
The paper proves benefits from application of 5S practices, as well as methodology that was applied to implement it. The area in which 5S was implement is warehousing, hence the characteristics and analysis of the warehousing process in a manufacturing company are considered. Warehousing and stock management influence efficiency of manufacturing process, which is the reason why the authors selected such scope of the research. The characteristic was based on observation and experience of one of the authors, professional work and interviews with people directly involved in the process analyzed. The analysis motivated the authors to take an interest in 5S practices and its implementation, that resulted in improvement of efficiency and effectiveness of the warehousing process in herein company. Ordering and cleaning the storage space leads to its better utilization, increasing safety and improving the working conditions of employees. Other results expected are improved communication and cooperation between the warehouse staff and subcontractors, and shortened lead cycles. In the longer run, implementation of 5S practices is the initial phase for the implementation of Lean Manufacturing in the company.

Keywords:
5S practices, warehousing, DMAIC methodology.

1 INTRODUCTION
5S acronym is widely known as initially based on the Japanese acronyms of seiri (organisation), seiton (neatness), seiso (cleaning), seiketsu (standardisation) and shitsuke (discipline), and the S translation is often adjusted to fit the words in a given language connected somehow to the idea. A common definition of 5S in the West is “housekeeping” [1, 2, 3, 4, 5]. A framework of applying 5S within a business (as opposed to a personal philosophy of way of life) was first formalised in the early 1980s by Takashi Osada [6]. The practice of 5S aims to embed the values of organisation, neatness, cleaning, standardisation and discipline into the workplace [7]. In Japan the 5S practice was initiated in the manufacturing sector and then extended to other industries and services sector [8]. The Toyota Production System provides a well-known example of 5S principles in practice, the early versions were based on 3S and then developed into 4S [9]. Boeing in the USA pursues 5S as a world-class strategy [10]. However, Hyland and others suggest that many researchers and practitioners have difficulty going beyond the simplest 5S concept (or meaning) of “housekeeping” [11]. These authors found of ten continuous improvement tools they investigated the usage and perceived importance of 5S was low ranked. It would appear at the abstract level, 5S is “easy to understand” [1, 5, 12]. It seems far more difficult to fully understand what lies behind 5S when developed as a value driven business model [8]. In addition it is also believed that some definitions applied to 5S in the west may confuse practitioners [13, 14], compounding the difficulty the West has in fully appreciating the benefits of 5S as an organisational wide strategy for improving organisation decision making and performance.

The paper proves benefits from application of 5S practices, as well as methodology that was applied to implement it. The area in which 5S was implement is warehousing, hence the characteristics and analysis of the warehousing process in a manufacturing company are considered. Warehousing and stock management influence efficiency of manufacturing process, which is the reason why the authors selected such scope of the research. The characteristic was based on observation and experience of one of the authors, professional work and interviews with people directly involved in the process analyzed. The analysis motivated the authors to take an interest in 5S practices and its implementation, that resulted in improvement of efficiency and effectiveness of the warehousing process in herein company. Ordering and cleaning the storage space leads to its better utilization, increasing safety and improving the working conditions of employees. Other results expected are improved communication and cooperation between the warehouse staff and subcontractors, and shortened lead cycles. In the longer run, implementation of 5S practices is the initial phase for the implementation of Lean Manufacturing in the company.

2 5S IN A WAREHOUSE – RATIONAL AND BUSINESS CONTEXT

Introduction of 5S practices in every department in the company is possible thanks to its appropriate preparation. First of all, it is necessary to identify and analyze problems in the department where 5S practices are to be implemented. These practices greatly contribute to the reduction of waste, which is the main element that should be eliminated in order to implement Lean Manufacturing in the future.

In practice seven types of waste (muda, which also can be referred to as problems in the company): can be distinguished

- overproduction,
- excessive inventories,
- unnecessary transport,
- waiting time,
- unnecessary movements,
- improper processing,
- defective products and repair.

When a storage system is disordered waste occurs very often. In most cases, the waste can be prevented by an appropriate organization in the warehouse. 5S practices can help to organize and tidy a storage area. An important element is to identify areas separating stock. These are mainly: passages, corridors, transportation roads, storage locations, special storing places and social facilities for warehouse workers. It is necessary to appoint a person coordinating implementation of these practices, and then controlling their use by warehouse workers, as well as analyzing implementation results.

Only after precise planning of 5S practices implementation in the warehousing area and determining the objectives to
be achieved, successively all the "pillars" (elements) of 5S can be introduced. The company is a joint stock company and a leading manufacturer of professional lighting products. The size of the investment market in Poland is estimated at approx. PLN 900 million, and the company is the second among manufacturers, with more than 9% share. Thanks to cooperation with the largest electrical wholesalers and its network of representatives, the company is widely recognized as the one providing high quality of lighting equipment. Expanding exports to 38 countries in the world, the company became an unquestionable leader among Polish exporters of professional lighting products with a 15% share in total exports.

The company is large, and to stay competitive and agile [15] it requires constant changes throughout the production process. Therefore, changes are also necessary in the process of warehousing. The company analyzed has developed and grew over several years. Preliminary a warehouse was a very small room and was maintained by one person. Over time, as business grows a storage place increased. In the years 2000 - 2007 the warehouse increased its surface to approx. 3,000m², to finally move to the newly built production hall and warehouse with an area of almost 12,000m². Initially it was a low-storage warehouse, and it was re-equipped to high storage later. As the needs arose the new employees were needed. Currently, the warehousing process despite its proper identification and the introduction of procedures of ISO standards shows many imperfections in the daily operation of the facility. First of them is a very long waiting time for contractors to release the material for production. This situation has a close relationship with the lack of organization of warehouse operation. Materials are taken just from the first free space, without any systematic approach. Warehouse staff do not know where the relevant materials are located to collect them for subcontractors, because the materials are located in different areas of the warehouse. Therefore the employees make long distances in order to find an appropriate material.

There are also problems with locating stored items/materials, because there is no appropriate markings on the storage racks. The material completed for release is in many places in the store, because there is no space designated strictly for intermediate storage nor place for materials collected to be released. Similarly, the purchased materials can be found in many places, because there is no one place designated as intermediate storage space for these materials.

The consequence of such situation is quite a chaos between reception and issuing of materials. In addition in the warehouse there are damaged materials stored that do not have specified location and are not sorted in any manner. These materials are purchased from various sources from subcontractors, from development department, from quality control department and finished goods warehouse. Many of them cannot be used in any way. Often these are the materials that have already been withdrawn from the production due to the loss of the safety certificate or properties that enable their use. Despite this, they are still in stock and are moved from place to place. No markings and designated spaces for different types of materials, or equipment to work on the magazine gives the impression of general chaos and disorder. Work cannot be conducted properly in such environment. Employees in the warehouse are not assigned to their individual zones for which they are responsible, and everyone is responsible for everything. In such a situation organization of any of the storage areas is impossible. Much of the material in this storehouse is damaged during very frequent relocations. This causes additional losses, and thus additional, unnecessary costs in the process of storage. The storage process is not a process that adds value to the finished product and the costs associated with it should be, if not eliminated completely, kept to an absolute minimum. Time lost by subcontractors to wait for the release of goods is also a big expense for them and this situation also adversely affects the atmosphere of cooperation.

The reason for such situation is the lack of training on 5S practices or Lean Manufacturing and the lack of any information on contemporary methods of working in such a large warehouse. The situation is due to a very rapid development of the company and the introduction of ISO procedures, but omitting many important points in hereby process. Warehouse was not properly adapted to such action, and the staff was not properly acquainted with the whole organization of the system. The rate of production and the influx of new material for the magazine also prevented the introduction of the subsequent stages of the correct taxonomy of materials in the right way. This process nevertheless differs greatly from what is included in ISO standard requirements.

3 5S IMPLEMENTATION

Due to the difficult situation of the warehouse, appropriate measures have been taken to change this situation. A decision was made to introduce 5S practices, which greatly facilitate the work within the warehouse. For this purpose, the schedule has been developed to introduce 5S practices, with particular emphasis on the various stages of the implementation of all its pillars. The whole process of change was based on the DMAIC method (an acronym for Define - Measure - Analyze - Improve - Control). This method is a general procedure designed to lead to a specific, intended purpose most often used in quality management systems [16]. The characteristics of the DMAIC cycle shown in the following figure:

![Figure 1. DMAIC cycle.](image)

The cycle starts with definition stage. In the company there is a problem with materials releases to production stage to subcontractors. In the past few years there has been a significant increase in production without any investment in human resources or changes in the system of in-house material management. A chaos has been caused by lack of storage procedures and no adequate trainings for personnel.

The warehouse has become one of the bottlenecks that block the flow of materials in the most important places of the entire production system in the company. In the warehouse, there are problems with the location of
materials in stock and it significantly prolongs the completion time to release goods to the individual subcontractors.

It is a very difficult to clearly define in a measurable way, how much time is required for completion of the order for a subcontractor, in such a way that they can be compared, because each job is different (different amounts and different ranges), and each is performed by a variety of warehouse operators. It results in queuing the material waiting for release for subcontractors, because warehouse operators are looking for materials in stock to complete order picking. Material and finished goods are placed in different locations, varying from one delivery to another, hence the problem with finding its location. In addition, supplied materials are queuing as well, because there is no space for unloading. All of this is a reason of a nervous atmosphere and general disarray in stock. After the problem is defined the expected improvement should be defined as well.

**Expected benefits of implementing 5S practices**

1. in the strategic aspect - organization and systematization of this warehouse
2. reduction in the cost of purchases of materials and reduction material losses
3. in the internal processes aspect - the ability to better determine the location of the material in stock
4. in the clients (contractors) aspect – shortening lead times, shortening picking materials to orders
5. in the staff aspect - employee satisfaction with their work, better atmosphere and motivation to work
6. the other - is to improve the overall image of the magazine.

**SIPOC (Suppliers, Inputs, Process, Outputs, Customers)** is a tool to identify the elements of the process before its realization in accordance with adopted rules and agreed upon criteria [18]. SIPOC analysis conducted for this project divided all the element of in the process as follows:

- **Suppliers:** warehouse workers, suppliers, subcontractors
- **Inputs:** materials and semi-finished products for production in stock
- **Process:** reception of the material, verification of material, storage of material, release to manufacturing, production, control of the final product, selection of materials for production
- **Outputs:** complete material released to production, the final product
- **Customers:** contractors, warehouse of finished products

The human factor and its operation in work environment [20, 21] seems to be really important for 5S implementation, and as a beneficiary of its implementation.

The next stages of DMAIC is Measure and Analyze, and in the procedure these stages were combined. This is due to the fact that it is not possible to determine precisely the time to prepare and release a single order from the store, because of the diversity and uniqueness of all orders. "Brainstorming" carried out in the company revealed the main cause of the problem and they are presented in a matrix diagram, Ishikawa diagram and ABCD analysis.

**Matrix diagram**

The table has been designated by the key participants in the process to present errors in storage process and their validity determined by these attributes. The table shows that the most important are the three main problems that are clearly different from the other, simultaneously they are component of simple 5S practices (Matrix is presented in the figure 2).

**Ishikawa diagram**

As with the matrix diagram shown in Figure 2 so that the diagram can present the main problems of the warehousing process and, more importantly, the problems here are defined in greater detail. The Ishikawa diagram is presented in the Figure 3.

**ABCD analysis**

The last aspect of the Measure and Analyze stage was ABCD analysis. The results of the analysis are presented in the Figure 4.

An analysis of the force field indicates predominant number of positive factors (80) over the negative factors (-53) After the Measure and Analyze stages, there is the Improve stage. The improvement is based on 5S implementation. The measures necessary for the introduction of 5S

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**Figure 2. Major errors in warehousing process.**

<table>
<thead>
<tr>
<th>Attributes perceived by the customer</th>
<th>Speed of service</th>
<th>Completeness of materials</th>
<th>Work safety</th>
<th>Easy location of materials</th>
<th>Collection efficiency</th>
<th>Lack of mistakes in picking</th>
<th>Packing in smaller packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sum</td>
<td>161</td>
<td>344</td>
<td>264</td>
<td>315</td>
<td>238</td>
<td>378</td>
<td>289</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Importance of parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>161</td>
</tr>
<tr>
<td>344</td>
</tr>
<tr>
<td>264</td>
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<td>238</td>
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<td>378</td>
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<tr>
<td>289</td>
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<tr>
<td>158</td>
</tr>
</tbody>
</table>
Before the introduction of practices staff training warehouse is needed, aiming to:

- The change in awareness and motivating employees to change, to facilitate their work,
- Presentation of employees ideas concerning 5S practices and belief in the rightness of their application,
- Overcoming the fear of the staff of changes,
- Mastering the skills of identifying problems and eliminating workplace characteristics that affect its ergonomics and quality of labor,
- Developing skills and to adjust the system to the specifics of 5S processes in a given place
- Getting to know the tools and methods to support the development of a visual management system in the workplace

After training session, 5S practices can be implemented.

**1S – selection – taken actions**

- Determine the criteria to recognize the general materials and all unnecessary items
- Provide information about the criteria to warehouse workers
- Introduce the concept of "red label" - "red label" is a red card or a sticker applied to items that are in stock, for which there is a suspicion that they are unnecessary.

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**Figure 4. ABCD analysis** (I – corrected summary; II – number of responses after the rejection of the stress response; III – status indicator (I/II); IV – status).

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you can label all items: materials, raw materials, parts, products, machinery, equipment, appliances, fixtures and tools, carts and even surfaces, floors, shelves or racks

- design a "red label" and provide information to employees how to properly use them,
- appoint a temporary space for the "red label" items
- using "Red Label" and the transfer of these materials for temporary storage
- repeat all the steps above at regular intervals

2S – ordination – taken actions
- paint surface storage in a fixed color (road transport, waste storage and disposal, intermediate storage space, space for materials entering the warehouse, space for outgoing materials, space for hazardous materials and areas that need attention due to safety)
- specify the destination, marking the appropriate banner, numbering shelves
- mark the location of everyday objects by relevant signboards
- indicate the places of storage of production materials labels, where possible

3S – cleaning – taken actions
- Informing employees about the necessity of cleaning as a daily routine
- Determining the scope of cleaning (daily and repeated every few days)
- Description of cleaning
- Selection of persons responsible for cleaning in various places
- Preparation of technical means to perform the duties of cleaning
- Launching cleanliness and purity surveys
- Maintain cleanliness in stock

4S – standardization – taken actions
- Consolidation of the first three S model by setting standards and procedures
- The choice of the persons responsible for the various activities in the framework of the conditions of 3S
- The inclusion of measures to maintain 3S daily job responsibilities
- Assessment of the maintenance conditions 3S

5S – self-discipline– taken actions
- Build awareness among employees about the need for all pillars of 5S and the importance of maintaining them
- Separate time in the daily schedule of work needed to talk with their employees to the current error detection while maintaining 5S
- Create an appropriate structure of the organization of work in order to maintain 5S practices
- Support from management
- Development of employee motivation in order to maintain 5S practices (bonuses)
- Take action within the 5S practices bringing employee satisfaction and provide pleasant working

The last stage of DMAIC is Control. Control is generally performed after each stage of 5S because it is impossible to make the next step, if previous one have not been successfully completed. However, after the implementation of all the steps it is necessary to constantly monitor the maintenance of 5S practices. This inspection should be conducted in a regularly scheduled intervals, and follow-up requests must be presented to and discussed with all staff involved in the process.

4. CONCLUSION
Introduction of 5S practices in the area of warehouse management, in this enterprise, allowed to obtain the following benefits:
1. Management and the general order in stock
2. Improving the quality and working conditions
3. Improving the atmosphere at work
4. Increase awareness of employees and their work culture
5. Better utilization of warehouse space
6. Increased collaboration between the magazine staff and subcontractors
7. Reduced the picking time
8. Improved safety

Implementation of 5S practices in the warehouse led to a situation in which general order is perceived. This order has led to better use of warehouse space. Racks, road transport and intermediate storage space are properly labeled. By separating the appropriate places in the transport equipment, they have become more visible and road transport are not in arrears unnecessary materials which may cause difficulties in transport and the threat of destruction of materials. These actions resulted in the improvement of safety.

Implementation of 5S practices led also to improvement of the quality of working conditions in a warehouse. Improving these conditions had a positive impact on the atmosphere at work. Employees increasingly began to engage in the tasks performed, collaborate with each other and complement each other, especially when they are used for employee leaves or in the case of sick leave. Conducting appropriate training led to greater awareness of employees about the tasks and the culture of their work.

All of these activities at the same time led to a significant shortening of picking time, thereby strengthening cooperation between the staff of the warehouse, and subcontractors. The intended goal was achieved.

4 REFERENCES


