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Preconditions for Learning Factory

A case study

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Abstract

This paper discusses improvements of an existing manual assembly line for roller skis when it was used as a template for a learning factory in the university. These improvements were in terms of lean philosophy and operations management, angled towards the application of "flexibility" and "learning factories" concepts. The article introduces list of suggestions that were built up with the help of several techniques presented in the paper. These techniques can bring significant improvements if wisely applied. A novel contribution of this article is combination of theoretical knowledge with application of it to the real life case used to make necessary enhancements to increase production capacity of the assembly line and involve it into the learning factory.

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1. Introduction

Later years the concept of learning factories has gone from an idealistic idea to numerous implementations. Although, not every implementation can be classified as a full learning factory, there are some common features [1]. Universality, mobility, modularity, scalability and compatibility were identified as the first order parameters for ideal classification of a learning factory. Scoring on every parameter are difficult, however, Wagner et al. [1] claimed that most of them must be met in order to be a true learning factory. In this sense, they indicate that establishing learning factory is a dynamic and evolutionary process.

The word 'learning' somehow explains the popularity of implementing learning factory, especially in Europe. Learning is the opposite of teaching and emphasizes experiential learning or learning by doing. Greater retention is one of the positive sides compared to more traditional methods, like lectures [2].

To implement learning factory many universities look at an existing production line as a starting point. This does not mean that the learning factory implementation is a copy of the existing production line, but it is a sensible way to start. Differences in the means of learning factory compared to a normal production line ensure different features are emphasized. Or *"learning factories are not simply duplicates of industrial factories"* [1]. However, the benefits of a clear starting point in a real production environment is clear. This paper will look at this starting point and its preconditions are discussed.

This paper is the result of a project done in cooperation with the company TLI. Beside of the idea of using the manual assembly line as a template for a learning factory, the project had a goal to increase production capacity in four times.

Generally, four problem areas emerged from having a template for establishing learning factory. These are methods for improvement, what kind of improvement, learning areas coved by learning factory, and how to build more flexibility into the actual production line, as well as, into the learning factory.

Converging these problem areas into three questions for discussion sections of the article: Which exact improvements

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should be done to meet the project goals of using it as template for learning factory? How can a focus on learning factory help the existing assembly line and what are the benefits of its application? How is flexibility dealt with at the actual production line?

1.1. TLI and Their Current Assembly Line Condition

TLI is a Norwegian company, which has roller skis as one of its products. It was founded in 1995. Roller ski is a straightforward product, consisting of an aluminium profile with two specialized wheels at each end. It is used for training purposes in the summer time. There are many suppliers of roller skis in the market. Ski-on-snow-like attributes determine the best product. Roller skis come in many different varieties, but there are two main groups. Classic is for training the classical way of skiing and skating is the other. Those two are according to the two main techniques in skiing competitions.

The assembly line under examination was a manual production line situated in a separate room, where the workstations and all the necessary parts and materials where kept. There were several issues related to the current state of this assembly line. The first issue was related to the lack of clear organization of the parts that are supposed to be put together to produce a pair of skis. This adds time to the assembly, as workers are supposed to be moving all around the room to take the parts and come back to the working place. Also, it creates problems for easy access to the workstations and needed space, as some of the boxes are standing on the floor and hindering easy access.

The second problem is position of the workstations in relation to each other. They are not situated one after the other in a logical sequence of the manufacturing process, this makes it inconvenient for workers to do their job and takes time.

The third problem is that the tools used for assembly do not have a standard place to be put at, this can bring more chaos into the manufacturing process and again request more time for the concrete operation to be completed. Those were the major problems noticed after the first glance on the assembly line, however, they were not the only ones.

In addition to above mentioned problems, the production line was clearly missing the standardization component, as each of the workstations could have had a description of the best algorithm to be followed to complete the action in the most optimal time limit. Also, the boxes with parts for the assembly contained stickers with numbers of parts stored in them, however, for the person who is just beginning to work on the line, it takes a lot of time to understand which part is situated where, as he or she does not know numbered parts by heart yet. Those were the minor mistakes noticed at the second glance on the line. As it is described, it is easy to understand that the production line had a lot space for improvements, which will be described further in the paper.

2. Method and theoretical background

This section is going to give a short overview over the theoretical methods used in order to complete the project with TLI. It will also explain the reasons for choosing these methods and not the others.

As a case study, the research is meant to give a deep insight into several specific problems. Solutions and discussions are deeply connected to the specific context. In this sense, the general implications derived from this can be more limited. However, the authors strongly believe that insights from case studies ease the implementations of learning factories for others, but there are no one-way solutions.

2.1. Continuous improvement

Lean is one of the most mainstream techniques applied for optimization and assembly line improvements. It contains numerous tools and has a key principle that can be formulated as follows: *"moving towards the elimination of all waste in order to develop an operation that is faster, more dependable, produces higher-quality products and services and, above all, operates at low cost"* [3]. On the other hand, in [4] lean production is described as a *"set of practices that is used to continually enhance process activity that are necessary, relevant, and valuable while eliminate wastes"*.

While some scientists are criticizing lean for lack of proper definition, description, and explanation of use, as well as for lack of flexibility as shown in [5] *"lean requires a stable platform, where scale efficiency can be maximized. Highly dynamic conditions cannot be dealt with, as there is no room for flexibility due to the focus on perfection"*, others are giving examples of cases where it was successfully implemented and brought significant results. Thus, *"while some lean practices are easily applicable others are more difficult to implement particularly when the degree of mass customization (MC) increases"* [6]. However, at the same time, in [7] it was highlighted that certain studies have shown that lean manufacturing produces higher levels of quality, productivity and customer responsiveness.

In this study, lean was used as it is aiming to increase efficiency and effectiveness of the manufacturing process and can bring benefits of eliminating unnecessary waste, as well as increase production quality. Lean application was a request from the side of the TLI stakeholders. The main lean tools used within the project are 5S and PDCA cycle [8,9].

2.2. Operations Management

Lean and its tools can be useful while carrying out the similar studies, however, the other method that gives a solid basis for products manufacturing and process improvements is operations management. Operations management according to [3] can be defined as *"activities, decisions and responsibilities of managing the production and delivery of products and services"*. In other words, this technique is about managing processes during the product manufacturing and production.

There are six main activities within operations management that need to be followed according to [3]. The first activity is dedicated to understanding of the operation's strategic objectives and afterwards development of a clear vision about how to achieve the main goal. The second activity is about creation of an operations strategy for the whole organization, which guides the operations management team. Designing the operation's products, services and processes, is the third activity. The fourth activity deals with the planning and control over the operation. The next activity is about improving the