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## The Spread of Lean Production in the Assembly, Process and Machining Industry

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### Abstract

In Theory, Lean Production is commonly used across diverse industries and modern producing companies. This paper tests the theory by conducting a survey on the spread of Lean Production in the German speaking region (Germany, Switzerland and Austria). A system to measure the implementation level of Lean Production was established and used to examine 85 participating companies in the assembly, process and machining industry. With this survey the goal was to corroborate three underlying assumptions which are based on a comprehensive literature research. Additionally, barriers and critical success factors of Lean Production and the overall satisfaction with the implementation of Lean Production will be depicted.

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*Keywords:* Lean Production; quantitative analysis

### 1. Introduction

The Taylorism with its strong focus on the division of work can be seen as the first systematic rationalization of a production system [1]. Taylors "one best way" in which each step of a process is prescribed in high detail was adapted and refined by Ford. The centuries old traditional job shop production was converted into the new system of mass production [2]. In parallel Sakichi Toyoda, founder of Toyota Industries Co. Ltd., invented the automated loom - which was able to automatically stop when a thread breakage was detected - and thus implemented the "intelligent automation" (Jidoka in Japanese). From 1908 on Henry Ford build the Model T and with the pace and rhythm of production in mind implemented the first assembly line in 1913, which standardized processes and raised productivity to a new level. In the 1930s Kiichiro Toyoda, founder of the Toyota Motor Corporation and son of Sakichi Toyoda, implemented the assembly line at Toyota and developed the first adjustments towards Just-in-Time (JIT). In 1956 Toyotas later executive vice president Taiichi Ohno [3] went to the United States to visit automobile plants where he

discovered the pull principle. Ohno pioneered the concept of a leaner production at Toyota and substantially helped creating the Toyota Production System (TPS). In 1977 the first publication with the name TPS was issued [4], in which Toyota shared the experience with the production system. The TPS stands for more than just a collection of different methods, with its structure of the so called TPS-house [5]. The interlocking system of instruments facilitates continuous improvement in times of rising market volatility instead of static processes which are only capable of creating standard products in high volume. Besides the technical application of these methods, the human factor is considered significantly by the development and usage of the employee's knowledge. A plain usage of a method without the adequate implementation and development of employees is only of limited value [6]. In 1988 John F. Krafcik was the first who shaped the term Lean Production with his study "Triumph of the Lean Production System" [7]. James P. Womack together with his colleagues Daniel Roos and Daniel T. Jones brought worldwide attention to Lean Production with the publication of their book "The Machine

That Changed the World” [8] in 1990, which stands as one of the most influential economical publications to date [9].

This paper examines the spread of Lean Production in the assembly, process and machining industry through a survey. Based on the Toyota Production System a classification of methods in the six categories “Standardization”, “Visual Management”, “Flow”, “Quality”, “Continuous Improvement Process” and “Other Elements” was done. Through this, a mean could be calculated for each category and an overall score for the implementation level could be aggregated. Also of interest were typical barriers and success factors regarding the implementation of Lean Production. Additionally, the goal was to verify three assumptions which were formed through an extensive literature review. These assumptions were:

- Lean Production is most common in the assembly industry
- The implementation of Lean Production in the machining industry lags behind the other industries
- Methods of Lean Production typically need to be adjusted to the specific requirements of the process industry

The structure of this paper will from now on follow the format of the conducted survey, starting with structural data of the participating companies, followed by barriers and success factors for the implementation of Lean Production. Subsequently the spread of Lean Production will be examined and the satisfaction of the participants with the results of Lean Production and some interesting correlations will be shown.

| Nomenclature          |  |
|-----------------------|--|
| $\alpha$              | significance level                             |
| p                     | p-value  |
| $\sigma^2$            | variance                                       |
| $\mu$                 | mean   |
| $\mu_P, \mu_A, \mu_M$ | mean (process-, assembly-, machining-industry) |

## 2. Participating companies, barriers and success factors

### 2.1. Participating companies

The first objective of the study was to gather structural information about the participating companies to classify them by their size. Useful criteria were the number of employees in general, revenue and the number of employees in the relevant department. Here, it was asked if the participant would rather put himself in the process, assembly or machining industry. Some of the potential participants quit the survey at this point, since they could not position themselves in one of these areas. Overall, 85 companies participated of which 41% are part of the machining-, 26% of the process- and 33% of the assembly-industry. From here on, these industries will also be referred to as three groups, since the separation runs through the whole study. Most of the participating companies have between 250 and 4999 employees and a single factor analysis of variance showed that the three groups do not differ significantly ( $p=0.517, \alpha=0.05$ ). Similar results were gathered with the results for revenue and department size which helped with the

comparison of the three groups, since no major structural differences were present.

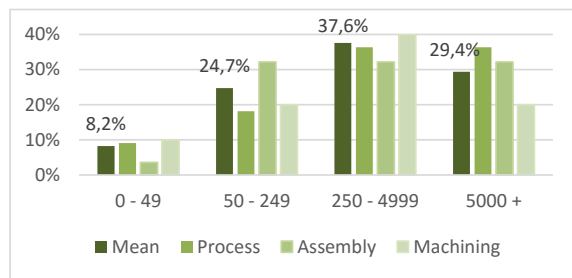


Fig.1: How many employees work at your company?

### 2.2. Implementation of Lean Production

In this section, the participants were asked since when their company has been implementing methods of Lean Production to a relevant degree. Furthermore, they were supposed to give a rough estimation on the level of Lean Production in their department as shown in Fig. 2.

On average, the companies started 10 years ago with the implementation of Lean Production, while the process industry lags around two years behind ( $\mu_P=8.6 \mu_A=10.44 \mu_M=10.72$ ). The most participants thought they “widely” but not yet “completely” implemented Lean Production. After a numerical transformation of the possible answers (“completely” = 3, “widely” = 2, “pilot project” = 1, “not implemented” = 0), the mean of the results is  $\mu=1.64$ . Separated into the three groups the results do not differ considerably ( $\mu_P=1.50 \mu_A=1.67 \mu_M=1.71$ ), which would contradict the first assumption and will be addressed again later. The difference between this self-assessment (Fig. 2) and the subsequent gathered implementation levels of Lean Production (Fig. 5) is quite noticeable. While 56% of all companies estimated to have a complete to wide implementation, the results of this survey rather conclude a subordinate condition.

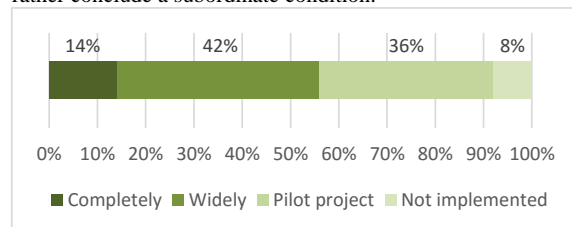


Fig. 2: At what level of implementation of Lean Production do you see your department?

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