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## Digitalization as a catalyst for lean production: A learning factory approach for digital shop floor management

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### Abstract

Digitalization and Industry 4.0 have a strong impact on today's production environment. The established methods of lean production are also affected and can be further improved through new technologies. The following paper addresses how and whether digitalization enhances shop floor management (SFM) as a key element of the philosophy of lean production. Based on the Darmstadt shop floor management model, it will be discussed where digitalization is expected to be value-adding or bearing risks in which elements of SFM and how the transition to a digital system opens up new possibilities. The potential of digital SFM systems are evaluated through a literature review and interviews with experts. Based on the results a digital SFM prototype is evaluated and further developed and applied to the learning factory Center for industrial Productivity (CiP) and its underlying process control system. The versatile environment of the learning factory is consequently being used for evaluation of digital SFM in different working situations like manual labor or machining.

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### 1. Introduction

The lean production system, which has been developed by Toyota for the last decades and is widely spread especially in the automotive sector, is a system of continuous learning and improving based on standards, values and qualifying every employee to become a better problem solver to continually reach more ambitious target states [1]. Industry 4.0 as a mainly technical improvement approach cannot replace the value based mind set of lean but it offers various

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opportunities to bring a lean system to the next level of excellence. Any digitalization should thereby address waste and reduce it more effectively than a classic lean approach could [2]. One of the key challenges is to determine the appropriate fields for digitalization to access all possible benefits of digitalization without the creation of new waste through disadvantages of digitalization. This area of conflict is addressed in the production environment of the process learning factory CiP by implementing new technologies in the brownfield of old machines and established lean value streams to continually improve and broaden the teaching content for students and partners.

One of the approaches is the digitalization of SFM as it is a central element to establish and maintain a lean production system. A software prototype for a digital SFM (dSFM) has been developed and connected to the IT-infrastructure of the CiP over the last two years building up on the research on analogue SFM. To improve the teaching content, identify the most important next features and to develop an implementation strategy for the dSFM it is now essential to look at the potentials and risks of such a system from the customer viewpoint.

## 2. State of the Art

The literature on digitalization of SFM is rather scarce. Few authors have tried to systemize the topic of classical analog SFM. Peters [3] has been one of the first to define SFM's objectives and fields of activity. Based on his work Hertle et al. [4] developed an advanced model structuring SFM, the Darmstadt shop floor management model. The structure of his work follows the SFM process (pic. 1).

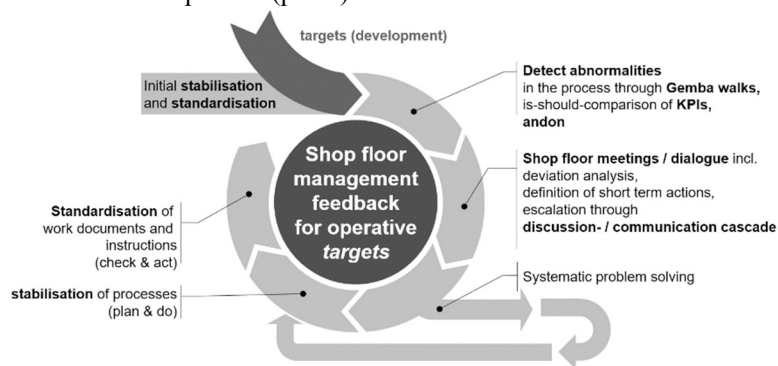


Fig.1: The SFM feedback loop [4]

The SFM feedback loop is supported through five fields of activity [4]:

- Performance management
- Problem solving management
- Leadership on the shop floor
- Further elements, which are not discussed in this paper

Possible benefits of digitalization are described by various authors. These will be matched with the fields of activity.

## 3. Methodology of research

To evaluate potential benefits and pitfalls of dSFM a literature review is conducted. As there are only few sources for dSFM the review contains mainly data about digitalization in general and this data is linked to the fields of activity. The result of the literature research process is a list of benefits and risks each assigned to one of the fields of activity. The assumptions made to link the general statements about digitalization to the fields of activity are validated through expert interviews.

The interviews are also structured according to the fields of activity and contain questions concerning benefits and pitfalls of SFM's digitalization. The objective of the questions is to identify the expert's opinions on the current state of SFM and to capture positive as well as negative expectations from digitalization. The experts have not been introduced to the findings of the literature to eliminate that bias.

The expert interviews were conducted at one of the partnering companies in the research project Teamwork4. Seven persons with extensive experience in the use of SFM participated in the interview. Six of the respondents have staff management responsibilities and use SFM for a successful leadership on the shop floor. The experts represented the business units of manufacturing, assembly, logistics, operational excellence and production management. The opinions were summed up and compared to the benefits and potentials of a dSFM.

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