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Integrating digitization technologies into resource efficiency driven industrial learning environments

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Abstract

Extending the traditional scope of industrial lean management oriented learning factories led to the creation of numerous sustainability driven learning environments in Europe in general and especially in German. We focus in this paper on integrating digitization technologies and methodologies in existing learning labs. Deriving the actual specific local need in an enquiry amongst industry decision makers led us to the conclusion to exemplarily highlight the topics of autonomous intralogistics and machine tools as showcases in this contribution.

Keywords: Sustainable Manufacturing; Digitalized Learning factories; Manufacturing Excellence; Resource Efficiency

1. Introduction

1.1. State-of-the-art

Looking on the implementation of digitization technologies initial situation in medium sized manufacturing companies is often characterized by a low data quality level and a heterogeneous data landscape [1]. In practice, operating parameters of assets in manufacturing and operation states of machinery are often intransparent. This non-transparency represents a critical success factor when it comes to optimizing resource use in manufacturing.

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Digitization allows the creation of a homogeneous database in so called data lakes that serve as a starting point for advanced data analytics to increases resource efficiency [2]. Considering existing approaches to increase resource efficiency, especially energy efficiency has been broadly discussed [3, 4], since it is benefit can be clearly calculated and measured. Furthermore, approaches coming from Product Service System offer can serve as a starting point for further investigations, since they offer a good structure and data availability all along the product life cycle [5, 6].

1.2. Research requirement

Regarding resource efficiency of industrial manufacturing, in most cases it is still seen as a side effect when using digital technologies for instance being associated with process automation. Currently, a systematic success control for tracking and quantifying resource savings is not yet broadly established. Businesses lack the information on their operational resource requirements, which they could use to derive optimization measures. The creation of transparency and a standardized method are particularly necessary in intralogistics. The high potentials currently can only be estimated and not yet systematically improved. Cross-industry estimates show that logistics accounts for 40% [7] of a product's energy costs, with intralogistics accounting for 25% [8]. Hence the systematic measurement and evaluation of resource consumption is therefore an indispensable prerequisite for leveraging resource efficiency potentials in manufacturing companies.

2. Didactic set up

2.1. Scope and learning goals

The presented work primarily focuses the training on the job approach for industrial engineers in medium sized companies. Furthermore, prospective engineers in university education are sensitized regarding the subject of resource efficiency to gather valuable skills before they start their industry careers. Analyzing the maturity level in 20 medium sized companies reveals a gap between current state and the target during the individual process of digital transformation (Table 1).

Table 1. Transfer of digitization methods in mechanical engineering (n=20).

Maturity level	*Notation: (I: Rookie…VI: World Class Manufacturing)*	Current state	Target
I:	No data acquisition, data are singularly acquired triggered by events	5 %	*
II:	Periodic data acquisition on process level	40 %	*
III:	Periodic data acquisition per machine or process step	15 %	5 %
IV:	Integrated data acquisition and warehousing e.g. in a data lake	25 %	10 %
V:	Data based deriving of optimization measures (event-triggered, manually)	10 %	20 %
VI:	Data based deriving of optimization measures (periodic, automatically)	5 %	30 %
	*No target specified yet		(35 %)

Looking at the obtained results of the mentioned inquiry conducted by the authors of this paper clearly show that the majority of general managers (40%) assess the digitization maturity of their company to be on the second stage, meaning that data are acquired on process level. As a target those experts would either like to derive optimization measures (level V or VI) or –as a majority of 35%– have not yet clearly figured out which target should be set. Therefore, we conceive that the aim of this contribution is to increase the ability of industry decision makers to reduce the resource requirements in manufacturing by applying suited digitization technologies and methods. Therefore the training participants:
- learn conceptual foundations in the context of digitization
- are familiar with practical aspects of selected approaches of digitization in production processes
- are able to implement selected methods of digitization and their field of application in practice