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Learning factory requirements analysis – Requirements of learning factory stakeholders on learning factories

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Abstract

In recent years learning factories are object of extensive research, emphasized through comprehensive discussion on this topic. The international community of learning factories has reached a common understanding of the definition and differentiation of learning factories. Nevertheless an analysis of the heterogeneous stakeholder demand on this complex learning system is still missing. So, this paper provides a study on the requirements of selected stakeholders on learning factories. A description model of the system learning factory on three levels and six dimensions serves as a basis and ensures the consideration of various expectations and distinct learning factory concepts. Subsequently, predefined hypotheses regarding the requirements of stakeholders on learning factories are tested and most important requirements are identified. The stakeholder demands analysis is the foundation of a quality system for learning factories, which is currently in development.

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Keywords: learning factories; requirement analysis; stakeholder

1. Introduction

In the production domain various learning factory approaches are established for practice- and action-oriented learning in recent years [1]. Learning factory courses enable a high potential for competency development [2, 3, 4] by linking the thinking and doing of the learner [5], i.e. active participation in order to gain practical experience as well as the systematization and transfer of domain-specific knowledge is facilitated in learning factories.

The learning factory concept can be adapted and implemented in a great variety [1, 6]. Thus, in order to exploit the potential, it is essential to examine the requirements of various learning factory stakeholders on the leaning factory itself. This way, the design and use of learning factories can be geared to the stakeholders needs. This paper presents an approach for the systematic requirements analysis of various stakeholders on the learning factory system.

2. Understanding and description of learning factories

Inside the CIRP Collaborative Working Group on "Learning Factories for future-oriented research and education" the international learning factory community established a common understanding and description of the learning factory system, see e.g. [1, 7]. There, learning factories are differentiated in learning factories in the narrow and in the broader sense [1]. While learning factories in the narrow sense manufacture physical products, have a real value chain and learning takes place on the factory-site, learning factories in the broader sense extend the learning factory concept for example to services (instead of physical products), a virtual value chain or a remote learning approach as shown in Fig. 1. The research presented in this paper refers to learning factories in the narrow sense focusing on production process optimization following the lean philosophy.

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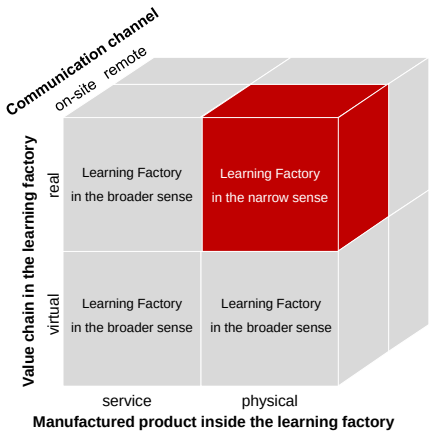

Fig. 1. Distinction between learning factories in the narrow (red cube) and in the broader sense (all grey fields) [1].

Figure 2 shows the key features of learning factories in the dimensions purpose, process, setting, product, didactics and operating model according to [1]. Additionally the (industrial and academic) learning factory systems involved in this paper are classified in figure 2 on the basis of these characteristics.

The design dimension “purpose” describes the kind of learning, which takes place in the learning factory: education and/or training and/or research. “Process” as a dimension covers topics like the design of the product used, presented technologies and the order lifecycle. The processes have to be authentic, multi stage and technical as well as organizational to ensure a proper competency development. The “setting” has to be changeable, so the learners may conduct experiments with the given factory environment.

A physical value chain with a high degree of contextualization increases the hands-on experience. The product of the learning factory is a core element of trainings. This design dimension could either be physical or a service. Some products are designed only for one use case; in other learning factories products, which are available at the market, are manufactured. The design dimension “didactics” refers especially to the factory as learning environment. A didactic concept serves as basis for learning modules, formal, non-formal and informal learning processes are conducted during learning situations in which participants master unknown problem situation. Furthermore learning factories in the narrow sense use an on-site (factory site) learning approach, whereas such in the broader sense learning processes may also be performed remotely. Finally, the dimension “operating model” describes the possibilities to ensure the built-up and ongoing operation of the learning factory related to content, economy, and personnel [1] [6]. For an extensive description of the dimensions see [6].

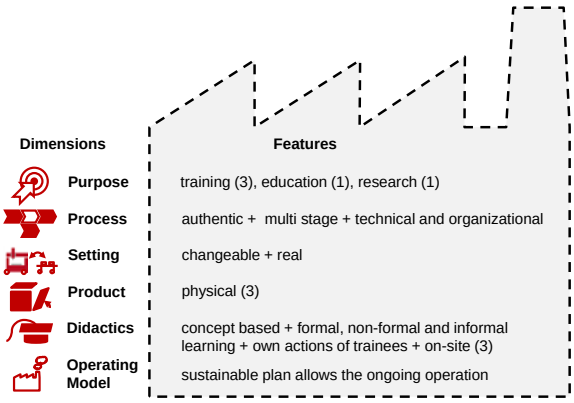

Fig. 2. Classification of the three examined learning factories (numbers in brackets show quantities) (referring to [1]).

The dimensions are further detailed in design elements. For instance, the design dimension “operating model” has the design elements operating organization, trainer, development, initial funding, ongoing funding, funding continuity, and business model for training. The design dimension is concretized with the design elements and by adding possible characteristics for those elements a morphological box for each dimension is created – combined, the six morphological boxes are referred to as learning factory morphology [6]. With the help of the learning factory morphology it is possible to describe, classify, and differentiate learning factory application scenarios [1].

Additionally to the morphology, in context of a learning factory design approach, three design levels of the system learning factory are identified, to structure the otherwise diffuse concept: [8]

- a macro-level, which covers the socio-technical infrastructure as well as the rough learning factory concept,
- a meso-level, which contains learning modules and courses, and
- a micro-level, which details the learning modules in single teaching-learning situations.

3. Combined description model

In the following the learning factory morphology [6] and the conceptual design levels [8] are combined to a comprehensive description model. Basis of this model are the three integrated conceptual macro-, meso- and micro-design levels (DL). The levels are crossed by the six interdependent design dimensions (DD). The design dimensions are operationalized with the help of 52 design elements (DE), while design elements may be either part of single, two or also all levels. Figure 3 visualizes the conceptual, qualitative relationship between

- the design levels,
- the design dimensions, and
- the design elements.

For simplicity and clarity, the mutual relationships among different design dimensions are not shown in figure 3.

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