Digitalisation toolkit for SMEs

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Abstract

The digitalisation toolkit combines technological and methodological competencies tailored for small and medium-sized enterprises. In a series of workshops, participants learn the fundamentals of process optimisation and digitalisation through a learning game and prototypical digitalisation of own use cases. Proving the potential for improvement of optimisation measures with concrete measured values is particularly difficult in flexible production environments without it support. This paper presents a technical solution that provides the necessary data for a performance analysis with process mining methods without technical preconditions.

Keywords

Industrie 4.0, Digital Transformation, Process Mining, Learning Games

1. Introduction

High investment costs, lack of technology standards and a lack of know-how and resources are obstacles towards a digital transformation SME in Germany have to face. [1]

Increased amount of data in production systems offer new possibilities for process optimization, though. Real-time acquisition, analysis and evaluation of process data offer the possibility of efficient control of production processes based on networked data sources [2, 3] and might justify the investment costs in new technologies. Based on this basic consideration, “Industry 4.0 out of the box” has emerged, a mobile solution for the fast digitalization of processes with the help of sensor technology [4].

However, the digital transformation cannot be managed with technologies alone. Know-how and a clear value proposition are equally important. The digitalisation toolkit combines technological and methodological competencies tailored for small and medium-sized enterprises. In a series of workshops, participants learn first the fundamentals of process optimisation and digitalisation through a learning game. Furthermore, based on company-internal use cases of the participants the benefits of digital transformation are demonstrated through a prototypical digitalisation of processes using sensor technology and smart services during a period of several weeks. This paper focuses on a technical solution for the necessary data gathering to evaluate the process improvements, which is part of the digitalisation toolkit. The learning game is used as an example.

2. Learning Game

The learning game depicts a traditional drilling machine factory. At different workstations drilling machines are manufactured in different variations. Figure 1 illustrates the manufacturing process of drilling machines the game covers, the process inputs and outputs as well as the work stations the processes are fulfilled at. The process begins with prefabrication of parts till the provisioning of the drilling machines to the customer. The participants take on the role of a worker and are distributed among the works stations.

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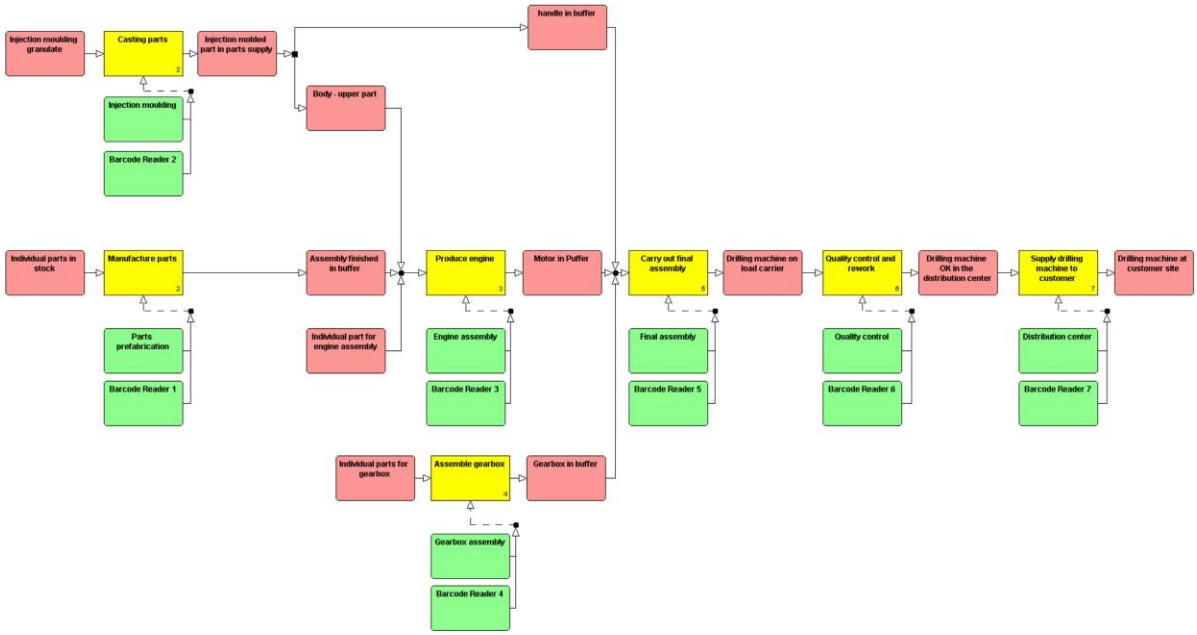

Figure 1: Example figure

Starting with a chaotic and complex production, the drill factory is transferred to a lean production system together with the participants. In the course of the training, they learn methods and tools to independently optimise the factory. The game already starts with a running factory. An error-prone production control and a function-oriented layout quickly lead to a chaotic state. Key figures such as delivery reliability or errors illustrate the effects on the profitability of the company. In a second round of the game, the participants themselves propose and implement optimisation measures. Usually, however, these measures do not lead to the desired improvements, sometimes the result even deteriorates. Using an integrated business process model, the trainer finally illustrates the complex control and order flow and the problematic dependencies in the existing layout. Now an optimised model is developed step by step together with the participants and its implementation is realised.

3. Technical Solution

In order to make the success or failure of the optimization measures clear to the participants, it is essential to underpin the individual game levels with key figures. Thus, the learning game differs from typical optimization and digitalisation projects in the industry only in its scope. Here, too, it is necessary to back up measures with facts to enable an evaluation. With the goal to gather process oriented-knowledge, a lot of research in the last decade focused on the application of process mining techniques in real business process analysis. By analysing event logs of information systems, such as manufacturing execution systems (MES), enterprise resource planning (ERP) tools or workflow management systems (WFMS), process mining can deliver useful insight into the actual behaviour of processes [5]. The three major analysis perspectives in process mining are process discovery, performance analysis and conformance checking [6]. However, widespread IT systems are not suitable for the constantly changing processes from the learning game, which reflects the challenges producing companies are facing, as order specific procedures become increasingly necessary [7]. This paper proposes a technical solution as part of the Digitalisation Toolbox to create event logs in flexible production processes to enable process mining techniques in order to analyse process performance.

The process in Figure 1 is modelled using the Integrated Enterprise Modelling [8]. During the different levels of the learning game, the participants adapt the model according to the proposed optimizations. Due to the possibilities of the IEM, the model includes not only the process flow itself, the model can be enriched by information, such as the work station, the manufacturing step is supposed to take place, the role who is responsible, the used machine or tools, etc.. Not only that, the information

flow as well as the input and output relationships can be mapped. Usually configured elaborately in ERP or MES systems, the proposed technical solution reuses these already available information by adding real time events. The core of the solution is the process assistant (PA). The PA is a tool that provides the internal processes, dependencies, responsibilities based on IEM models of process-oriented companies to various user groups in a format that meets their needs [9]. All the information an IEM model consists of is available and will be used to create the logs in order to enable process mining analysis perspectives. Therefore, the PA was extended by a new Application Programming Interface (API). With this API, it is possible to record events that occurred during a process (see Figure 2). REST, which stands for REpresentational State Transfer, is an architectural style for distributed systems, was first presented by Roy Fielding [10]. In this concept, it is used as an API for AutoID Systems, such as barcode or qr code readers.

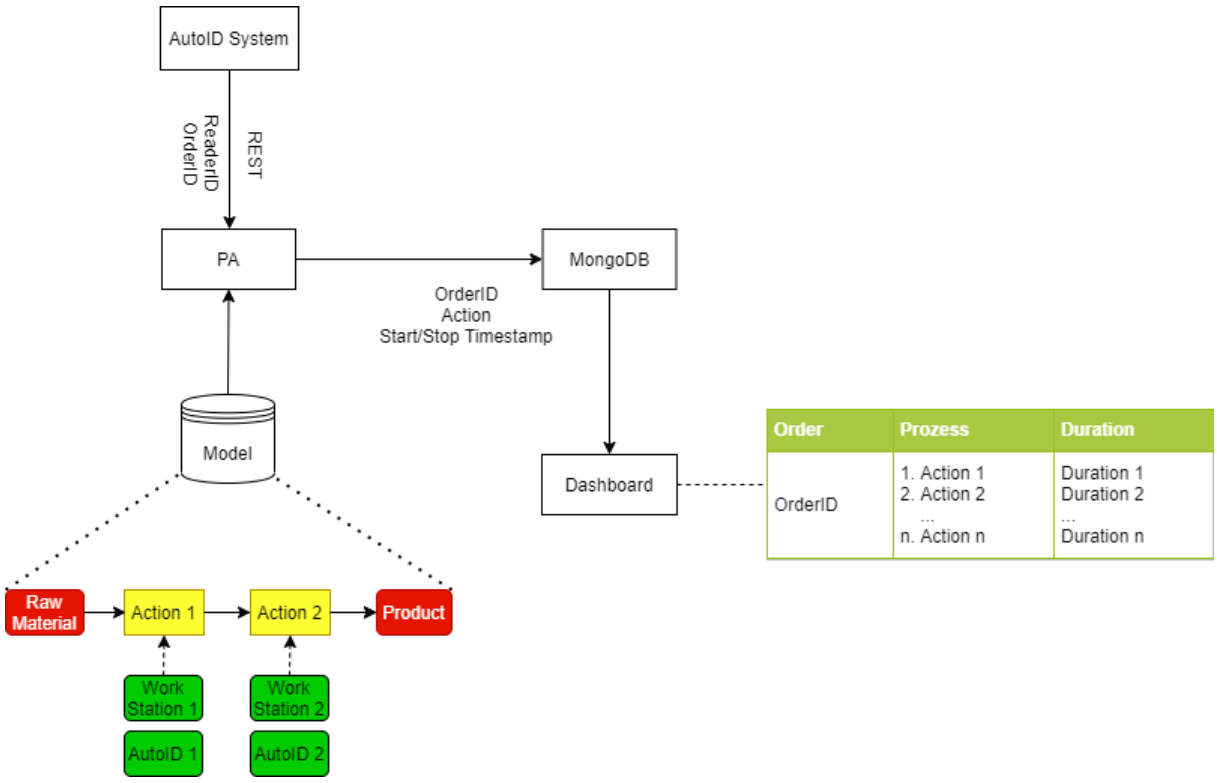

Figure 2: Example figure

This new API for the PA will be used, to track orders along the manufacturing process. It expects two values, a ReaderID, to identify the AutoID device the API is triggered by, as well as the OrderID, which identifies the product/product part to manufacture. The PA creates logs for every event triggered by the API and stores them in a MongoDB [11] database. A first event of a ReaderID and OrderID combination stores the OrderID along with timestamp in the database. A second event of that same ReaderID and OrderID combination is handled as a stop event, in order to calculate the process duration as the difference between the two events. Intermediate scans are treated as process interruptions. By facilitating the information of the IEM model, these events will be enriched by their context. As shown in Figure 2, every action in this example has connected resources, such as a work station, the action is supposed to run on as well as a specific AutoID system, which has a unique ReaderID as its metadata. That ReaderID connects the information within the model with the events triggered by the API. Using that information, it is now possible to link each unique event identified by OrderID and ReaderID with its corresponding action and its connected IEM objects. Through barcode readers at each workstation of the learning game it is now possible to track detailed process times of each step for each job. This information is made available via a dashboard and now enables statements to be made about the benefits of optimization measures.

4. Conclusion

Digital transformation can only be motivated by concrete benefits. Performance analyses with process mining methods can prove concrete benefits by before/after comparisons. The necessary data is often not available, especially in flexible manufacturing environments such as those found in SMEs. Proven in an educational game, the presented solution offers an easy way to collect the necessary data without technical preconditions.

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