Product Configuration Automation: Digital Transformation Platform and Case Study

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Abstract: The paper discusses more than 10-year experience in product configuration automation based on number of joint projects between an academic institution and an industrial partner. During the last years, the research and development in the era of digital transformation has enabled a shift from conventional company business processes to digital business processes. In the paper we present several business processes that have been successfully automated what in turn has significantly decreased the product configuration time as well as errors caused by the human factor. The following business processes are covered: identcode (product code) related procurement, product segmentation, delivery class specification, supply chain & production management; online & offline sales, and customer guidance. We present the developed platform to support these business processes that consists of 10 workflows. We have integrated the developed workflows to the company production processes and show that business process execution time in average has decreased by 2 times and for some processes by more than 10 times. At the moment, the developed platform is being successfully used by the company.

1 INTRODUCTION

Digital transformation is a new trend in the worldwide economy. Companies automate their business processes implementing various information technologies with the aim to increase their flexibility, efficiency and decrease their execution time. However, changes in business processes are often associated with difficulties related to the necessity to adapt existing data models and well-established processes to the new ones.

One of aspect related to digital transformation is the production strategy that determines a fundamental difference between B2B and B4B companies: business to business creates products and services to sell to customers, while business for business companies create products and services based on the needs of customers. Once again, we see that being able to listen to customers, detect their needs, and empathize with them is the key difference.

Another important concept related to the digital transformation is the digital customer journey that is related of the idea of providing a virtual solution consultant that bundles knowledge of company products and their interaction into a system and is at the disposal of customers and partners (Modic 2017).

Hence, digital transformation is strongly important for global companies. In the paper, we discuss a digital transformation platform developed within the scope of a research project with Festo SE & Co. KG. Festo is a global player and an independent family-owned company. The company supplies pneumatic and electrical automation technologies to 300,000 factory and process

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automation customers in over 35 industries. The products and services are available in 176 countries with about 20,700 employees in over 250 branch offices in 61 countries worldwide.

Data-driven digital transformation is the most popular approach (Gölzer and Fritzsche 2017; Pflaum and Golzer 2018; Wu et al. 2021). This approach is basically about analyzing existing accumulated data and building new (or modifying existing) digital processes around it. However, in the presented case, the driving force of digital transformation arose from the process automation department. The results of the process automation projects were presented in our previous publications (Smirnov et al. 2016; Smirnov et al. 2017). Hence a less popular process-driven digital transformation approach (Lederer et al. 2017; Juhasova et al. 2019) was chosen. The idea of this approach is to introduce the digital transformation for separate processes with their further integration into one digital eco-system supported by a common information platform.

In this paper, we share the success story and present the results of such a digital transformation process implemented for Festo SE & Co. KG. The main scientific contribution is a novel approach to business process automation for product configuration. The paper is structured as follows. The next section presents the related work in the area of digital transformation. Section 3 presents the platform. The particular processes are presented in section 4. It is followed by the description of the developed platform. The main results and evaluation of their efficiency are given in the conclusion.

2 RELATED WORK

Authors of the paper (He et al. 2021) propose to use data mining technology for product family design and product configuration method development. The method is based on customer requirement and product engineering information. They construct association rule-based classifier for sorting out the best product configuration schemes as popular product variants.

Authors of the paper (Zhao et al. 2022) focused on the product platform configuration by recognizing and utilizing shared product modules for product families. The approach considers the inherent relationship between product architecture and processing activities.

Authors of the paper (Shafiee et al. 2021) proposed a view-based approach required to fully conceptualize the knowledge to generate product configuration systems software. They propose to include four different views to build or edit all the required knowledge that increases the quality of such configuration as well as saves time and resources while improving overall configuration quality.

The paper (Shafiee et al. 2022) considers reconfigurable manufacturing systems to quickly reconfigure production capacities and functionalities. The authors carried out a case study in an engineer-to-order manufacturing company to analyze the benefits of a configurable product before and after integrating the relevant configuration systems with reconfigurable manufacturing systems.

The paper (Wang et al. 2022) proposes a hypergraph-based smart product-service system. Contrary to the conventional configurators that emphasize the mapping between technical attributes and product-service bundles, the proposed framework introduces the usage of the scenario information, which is usually straightforwardly expressed by users.

3 DIGITAL TRANSFORMATION PLATFORM

We propose a digital transformation platform that is based on company business processes. Digital transformation allows taking into account rules as well as making the platform user-oriented.

The platform is based on several workflows. Every workflow is responsible for carrying out required action(s) by one or several types of users. Different types of users can have the same functions in scope of a workflow or different ones. A workflow can support a company business process or support some auxiliary processes required for other workflows. Besides, the digital transformation platform supports rules that enable decreasing the human factor during the data maintenance by employers.

All data maintained in the digital transformation platform have SAP synchronization interfaces. Based on the amount of data and complexity of calculations it can be either online import/export or a script that runs nightly and implements everyday data exchange between the digital transformation platform and the company's ERP system based on the SAP. Also, the data maintained in the digital transformation platform is used in the "Product configurator" system (see Figure 1). The developed digital transformation platform supports processes to maintain (1) product characteristics as well as product families that define typical features for a set of products; (2) code scheme

that determines rules for particular product; (3) product including segmentation, delivery, and procurement. Based on these data it is possible to generate strategies related to production and sales as well as product management.

Figure 2 shows a typical ordering process on an example of the EU market. The ordering process includes several business processes as well as rules and participating users. A customer from Germany or Italy (DE/IT) makes a request about a product. The request comes to the Festo European office (Festo EU). Based on the information from the identcode (product code) related procurement (IRP) the platform identifies if the product can be delivered or it should be produced and then delivered. If the product is available in stock, the delivery class is determined based on the product segmentation (Festo CSC). If the product needs to be produced, its delivery class is determined based on the local delivery class information (EU).

Figure 3 illustrates the overall digital transformation process implemented in the developed platform. The rows are the processes automated via the platform. The columns are the digital transformation steps. They include (i) *gap analysis* (identification of process performance, automation objectives, and how to meet these), (ii) *design* of the digital processes, (iii) *development* of the corresponding workflows and supporting software tools, (iv) *deployment* of these, (v) *integration* with other existing digital workflows, and (vi) *refinement* (discovering and removing deviations, inconveniences, and missing functionality).

We designed every workflow based on the mentioned bellow digital transformation steps. As a result, every designed workflow passed all these steps.

4 BUSINESS PROCESSES

The section describes the company business processes that we automated. It includes identcode management, segmentation, delivery class maintenance, identcode related procurement, and phase out. Bellow we describe in detail each of them.

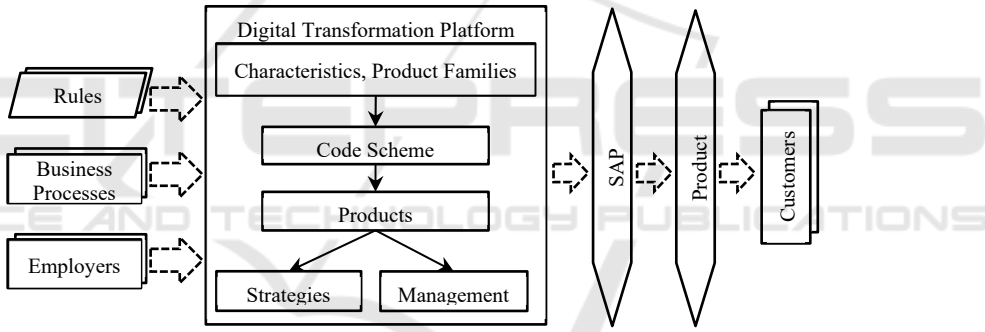

Figure 1: Digital Transformation Platform.

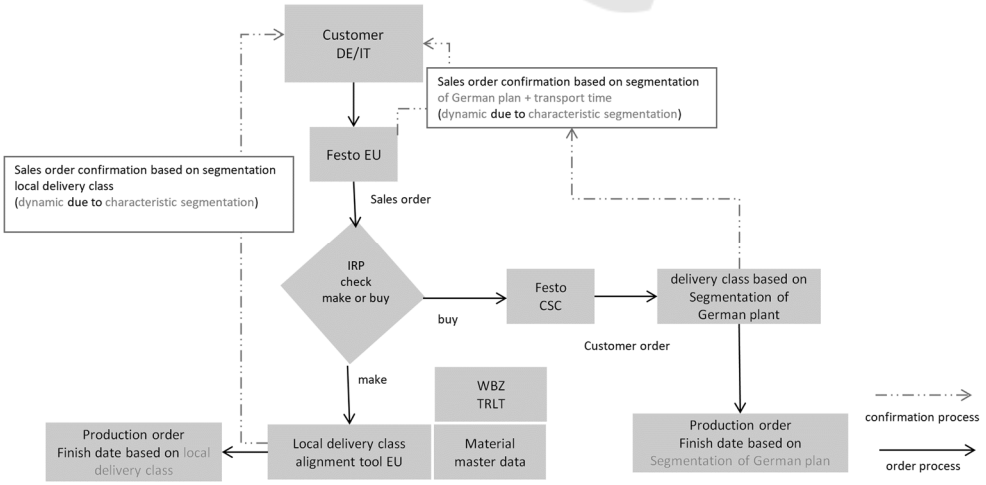

Figure 2: Ordering process at the example of Europe.

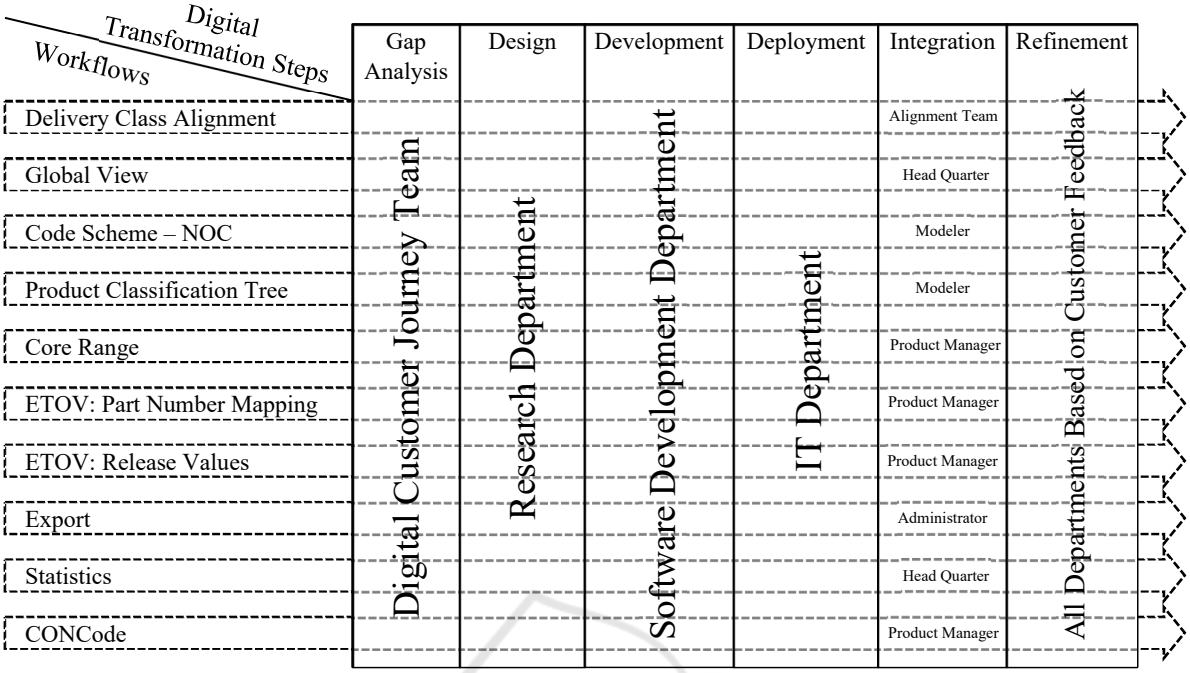

Figure 3: Digital Transformation Process based on the presented platform.

The identcode and order code team is responsible for code scheme generation based on the predefined rules (Smirnov et al. 2013). The identcode code consists of series from a product classification ontology (Smirnov et al. 2011) describing the family of the product, characteristics specifying names of the functions, values specifying different options, and sector delimiters logically dividing the identcode into several sections.

The segmentation panel team (product management, sales, and supply chain) divide all products for different segments based on the delivery time and pricing. Most important functions are specified as core range products related to one segment (Complete). Other products are related to the standard range that is another segment (Standard).

Delivery class alignment teams from different regions specify the product delivery time and the possibility to produce it based on customer needs for different regions. Delivery class is a KPI for a region related to delivery performance, e.g., 95% of products should be delivered based on the specified delivery class.

Global engineering department defines which values of the identcode should be produced by each plant. Every customer order is routed to the best possible plant. For example, an order is entered in Indonesia. The nearest plant for this order is in Singapore. If the Singapore plant does not produce this product, it will be automatically routed to the next nearest plant (e.g., a plant in China).

The phase out business process allows one to optimize production facilities for products that are not ordered frequently. For example, if the product has been ordered few times for a determined period of time it is reasonable to phase out the product and the company does not need production facilities related to the product.

5 DEVELOPED PLATFORM

In the section we describe in detail the developed digital transformation platform that supports the presented in the previous section business processes. We identified 10 main workflows that we describe in the section.

As mentioned before the developed digital transformation platform for product configuration automation consists of 10 main workflows (see Figure 4): Delivery Class Alignment (DLCA), Global View, Code Scheme – NOC, Product Classification Tree, Core Range, Expert Team for Open Variants (ETOV): Partnumber Mapping, ETOV: Release Values, Export, Statistics, CONCode.

DLCA, Core Range, and CONCode are the workflows for maintenance of the data that are stored in the platform's knowledge base as well as exported

to the corporate SAP system. These workflows are responsible to support the mentioned business processes related to the data maintenance (excluding the phase out business process)

ETOV: Partnumber Mapping, ETOV Release Values are auxiliary workflows that allow to setup the convenient work for other ones.

Global View, Code Scheme – NOC, Product Classification Tree, are the workflows that present the stored in the knowledge base information appropriate to decision support by a user.

Export workflow allows exporting information from the platform to the company SAP system.

Statistics workflow is aimed at calculating summary information related to the product and other product-related information in the platform that allow one to make strategic decisions (e.g., product phase out).

The DLCA workflow (see Figure 5) is proposed to maintain segmentation, delivery classes, and identcode related procurement. The user should specify the language, production plant and product family (series) and the system automatically shows product structure (product characteristics and values). The user has a possibility to see the current segment, delivery class, and identcode related procurement as well as to set new values.

- Segmentation allows one to split products into different segments based on local market needs and defines the delivery performance goal. Two types of segments are used: Standard and Complete (KS, KC).
- Delivery class specifies agreed time (in days) between sales and supply chain for configuration production and shipment.
- Identcode related procurement includes definition of production scope of configurable materials in different plants. In other words, it specifies which characteristics or values can be produced in which plant.

Global View (see Figure 6) shows delivery classes, local focus values, and identcode related procurement for all plants that allows supply chain stakeholders, production team, and sales staff to overview this information and use it for their business processes. The user can select preferable language and series and see the product structure for different plants.

The Code Scheme – NOC (see Figure 7) allows viewing the graphical representation of the code scheme for the chosen series that includes: identcode for each product, order of identcode letters and numbers, and an example of one correct identcode. A user can use this workflow to see schematic representation of how the product code is formed.

The product classification tree workflow supports definition of the identcode business process in the beginning of the product development process. The main users of the workflow are product manager, sales & online sales manager. The product classification ontology shows the classification of all company products and supports product type definition business process, see (Smirnov et al. 2011).

Core Range workflow (see Figure 8) allows maintaining core ranges for all configurable products for specified production clusters (a set of plants). The user can choose the language, cluster, and series. Maintaining is implemented for each value in defined production clusters. The workflow enables guiding the user among core range products as well as guide him/her to local market needs.

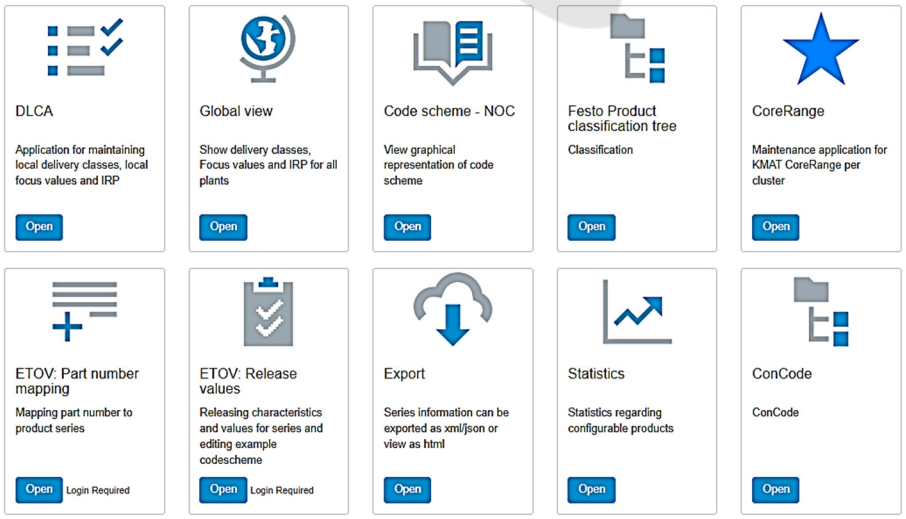

Figure 4: Developed platform that consists of 10 workflows.

Settings that are set in the tool are transferred directly to the company product configurator. The main users of the workflow are segmentation panel team (product management, sales, supply chain). The workflow supports the sales business process for guiding the user to the best option.

ETOV: Part Number Mapping workflow (see Figure 9) provides a possibility to create part numbers for product series. The user should choose the language and series. After that, he/she has a possibility to create new part numbers for this series. Open variants mean the configurable products in SAP. This is an auxiliary workflow that is used for data maintaining for other workflows.

ETOV: Release Values workflow (see Figure 10) enables releasing characteristics and values for series to activate released values per product for sales and editing examples of the codescheme application. The user can choose the language and series and decide which value should be released for production.

Export workflow enables exporting all information related to the series (Smirnov et al. 2011) and supports the following formats: xml, json, html.

Statistics workflow enables calculating statistics regarding to configurable products (the sales report for one or more materials of the last years). The workflow allows to calculate how often every value was sold. The workflow supports the following business process: sales, phase out. Besides, a special sales campaign can be launched to push more such products.

ConCode workflow is aimed for identcode (properties and values) definition based on product classification ontology (Smirnov et al. 2011) and creation of digital product (see Figure 11). The following users use the workflow: product manager, sales & online sales. The workflow supports the following business process: identcode definition.

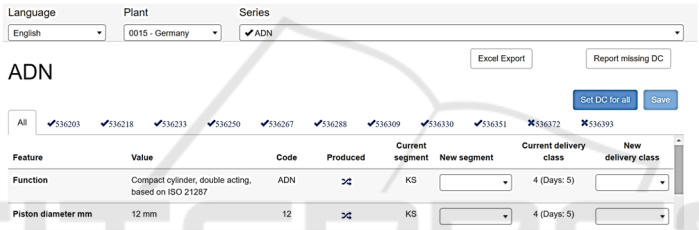

Figure 5: Delivery class alignment workflow.

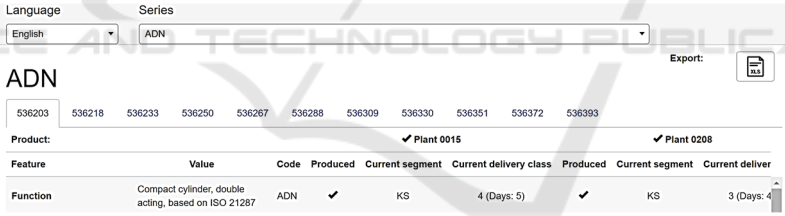

Figure 6: Global view workflow.

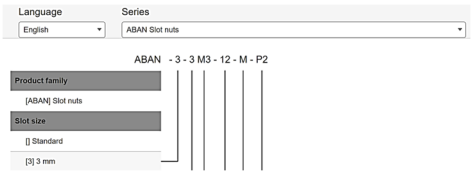

Figure 7: Code Scheme – NOC workflow.

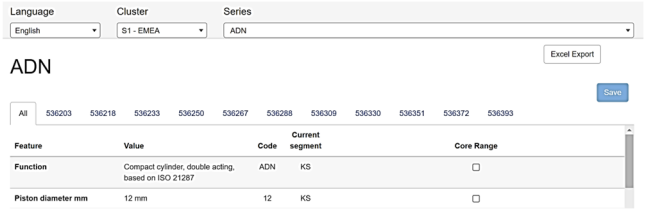

Figure 8: Core range workflow.

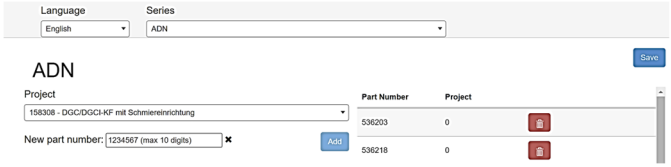

Figure 9: ETOV: part number mapping workflow.

Figure 10: ETOV: release values workflow.

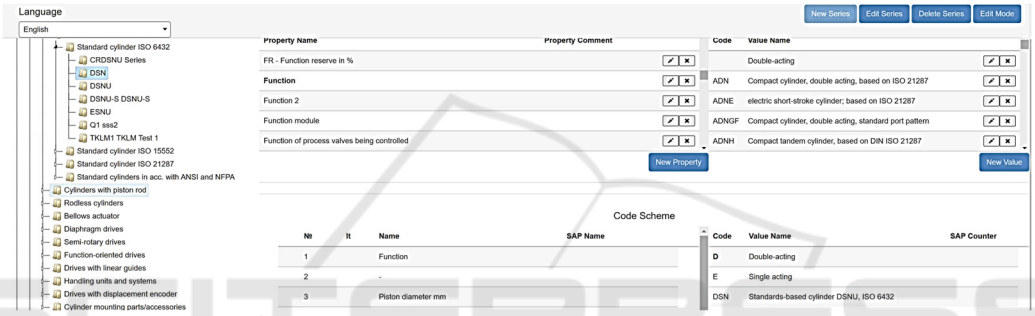

Figure 11: CONCode workflow.

6 CONCLUSION

The paper presents the results of the long-term digital transformation project in the area of product configuration implemented for the automation equipment producer Festo SE & Co. KG. The project was based on the process-driven approach since the driving force of digital transformation arose from the process automation department.

The project resulted in the development of an information platform supporting such processes as identcode management, segmentation, delivery class maintenance, identcode-related procurement, and phase out. The developed workflows made it possible to significantly speed up existing processes (Table 1).

Since identified business processes are complex they cannot be automated based on standard ERP systems. For this reason, we proposed an approach that uses the product classification ontology and automates the business processes.

According to the (S. Ransbotham et al. 2020) there are five levels of human-AI interaction that lead to better digital transformation results: (1) AI decides and implements; (2) AI decides, human implements; (3) AI recommends, human decides; (4) AI generates insights, human uses them in a decision process; (5) human generates, AI evaluates. Our platform is related to the “Human generates, AI evaluates” level since the maintaining process is implemented by humans and the evaluation is implemented by the AI.

Planned future work is aimed at both “in width” and “in depth” development of the platform. The former concerns implementation of additional workflows and integration of them into the platform. The latter concerns additional functionality for the existing workflows based on integration of new technologies into the platform, such as natural text processing and machine learning for predictive input, recommendation generation, and validation of the entered data.

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Table 1: Workflow efficiency improvement due to the developed platform.

Workflow	Duration without the platform	Duration with platform	Improvement (%)
DLCA workflow, local delivery classes	50 days	10 days	80%
DLCA workflow, IRP	20 days	10 days	50%
Analyzing delivery classes, focus values, and IRP	20 days	5 days	75%
Configurable product maintenance	40 days	20 days	50%
Collection of configuration and procurement information for all products	10 days	1 day	90%
Development of a product code for a new product	40 days	20 days	50%

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