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SIX SIGMA FOR SMART PRODUCTION SERVICES – TOWARDS A MODELING TOOL-BASED APPROACH

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SIX SIGMA FOR SMART PRODUCTION SERVICES – TOWARDS A MODELING TOOL-BASED APPROACH

Research in Progress

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Abstract

In the era of "industry 4.0", manufacturing companies are increasingly complementing their product portfolio with service offerings, so-called smart production services (e.g., maintenance works). In this respect, the quality of these services is decisive for truly creating added "value" for customers. However, smart service quality is an under-researched topic in the quality management discipline to date, and operational methods and tools are largely missing. In this research-in-progress paper, we introduce the reader to our effort to specify the established Six Sigma approach to work for smart production services and introduce a prototypical modeling tool to support such quality projects.

Keywords: Six Sigma, Smart Production Service, Metamodeling, Quality 4.0.

1 Introduction

Manufacturing companies – which have traditionally been engaged in the field of mechanical engineering and construction – are increasingly focusing on the service business nowadays to complement their product portfolio, e.g. by maintenance works (Herterich et al., 2015; Hübschle, 2017; Sony et al., 2020; Wirtschaftsverband für Industrieservice e.V., 2019). In this respect, production machines and plants are increasingly equipped with digital components and connectivity (e.g. sensors), which prepare the ground for "smart production services" (Anke and Krenge, 2016; Beverungen et al., 2017; Herterich et al., 2015; Wuenderlich et al., 2015). Contrary to classical services that complement physical products (e.g. consulting), smart production services are delivered with the help of a software system, in which the physical product is integrated as an external factor (cf. Metzger et al., 2017; Porter and Heppelmann, 2014), and they are primarily enabled by the user-related analysis of machine data (Anke and Krenge, 2016; Leimeister, 2012). In principle, various applications of "smart services" (Pöppelbuß, 2020) can be found in today's economy, such as "smart mobility services", "smart healthcare services" or "smart city services" (Acatech, 2016; Beverungen et al., 2017). Although the range of uses for "smart services" is broad, they are devoted significant attention in production industries in the course of the "industry 4.0" phenomenon as a means to outperform competitors based on innovative service complements, so-called "smart production services" (e.g. predictive maintenance for machines) (Anke and Krenge, 2016; Hänisch, 2017; Herterich et al., 2015; Hübschle, 2017; Pöppelbuß, 2020). In the following, we solely focus on smart production services in the course of the "industry 4.0" phenomenon to narrow the scope of our research.

In this regard, the quality of smart production services is decisive for realizing added "value" for customers (cf. Neuhuettler et al., 2017). However, current quality management methods (e.g. Six Sigma, Lean Management, etc.) and the scientific discourse focus on the quality of products (e.g. Garvin, 1984), physically-delivered services (e.g. Seth et al., 2005) or electronically-provided services (e.g. Santos, 2003) in isolation, neglecting the necessity to integrate these perspectives for improving smart services as *"data-based and technology-centered service offers"* (Neuhuettler et al., 2017, p. 309). An example of a smart production service could be a "predictive maintenance solution" for elevators (e.g. Acatech, 2016; Bosch, 2021; Thyssenkrupp, 2021), which enables reducing the elevator downtimes, since real-time data about an elevator's technical components are sent to a cloud, analyzed and maintenance workers are notified, if necessary (Acatech, 2016). In this context, the quality of the smart service depends on different aspects including the quality of the real-time data and the data analysis, the reliability of the elevator sensors and the process of repairing the elevator (physically), among others (cf. Neuhuettler et al., 2017). However, traditional quality management approaches lack an integrated perspective of these different dimensions (Neuhuettler et al., 2017). For example, in case the process of "repairing the elevator" by a maintenance employee was subject to quality improvement efforts for similar smart production service offers exclusively e.g. by using established methods like Six Sigma or Lean Management, an elevator could still suffer from faulty technical components – which cause downtimes – while the prediction of failure times may be imprecise due to insufficient data quality or improperly working data analyses algorithms. Accordingly, fault times would not be reduced in this exemplary scenario as the physical component (elevator) and the digital service (real-time data analysis) would be neglected by the quality efforts, and the smart service quality might remain beyond expectations. Hence, what is needed is a quality management method that not only focuses on the service process performed by people (in our example, the process of "repairing the elevator" by a maintenance employee) but also considers the reliability of the sensors that provide the data and the quality of the data analyses.

This research-in-progress paper introduces the reader to our ongoing work to adapt the established Six Sigma method (cf. Pande et al., 2014; Snee and Hoerl, 2003) for smart production services. In this context, we aim to integrate different perspectives that determine the quality of smart services (cf. Neuhuettler et al., 2017). Just like many common quality management methods, the classical Six Sigma approach strongly focuses on the business process – by thoroughly analyzing its activities – and mitigating process weaknesses or variances in the process performance (e.g. Magnusson et al., 2004). However, in terms of smart services and industry 4.0 settings, an additional consideration of "physical components" (sensors or devices) and "digital services" (e.g. data analyses) is required to derive a holistic quality assessment (Neuhuettler et al., 2017; Sony et al., 2020). Moreover, this paper presents the conceptualization of our adapted Six Sigma approach with the help of metamodels and its prototypical implementation in the form of a modeling tool. While applications of Six Sigma for production, service or software engineering processes are found in literature (cf. Antony, 2006; Antony and Fergusson, 2004; Mahanti and Antony, 2005), studies on its usage for smart services are currently missing. Hence, our investigation is based on the following research question: *What can an adapted Six Sigma method considering the peculiarities of smart production services and a supporting modeling tool look like?*

Accordingly, we contribute to the discussion on how established quality management methods can be adapted to work for smart services in the "industry 4.0" era (cf. Sony et al., 2020; Vinodh et al., 2020). In the next section, we introduce the reader to conceptual basics, before presenting the research procedure. Subsequently, the development of the Six Sigma approach and its prototypical implementation are described, before we conclude by outlining the benefits of the research and providing an outlook.

2 Foundations

2.1 Six Sigma

Six Sigma was initially developed at Motorola and gained tremendous popularity during its application at General Electric and Polaroid (Harry and Schroeder, 2000; Pande et al., 2014; Snee and Hoerl, 2003). Later on, Six Sigma also became a widely-recognized quality management approach for service industries (e.g. Antony, 2006; Breyfogle et al., 2001; Johannsen, 2011; Wyper and Harrison, 2000).

These days, Six Sigma is successfully applied in the financial service sector, healthcare industries or at software companies, among others (e.g. Alblooshi et al., 2020; Furterer, 2016; Heckl et al., 2010; Mahanti and Antony, 2005). Nonetheless, since business processes differ in the production and service sector, several challenges may occur when applying Six Sigma at service companies (e.g. a lack of measurement data, etc.) (cf. Johannsen et al., 2011). Generally, the Six Sigma method is structured by the DMAIC (Define, Measure, Analyze, Improve, Control) cycle, which specifies the phases to be conducted for improving a business process (Pande et al., 2014; Snee and Hoerl, 2003). Hence, in the *define* phase, the process to be improved is visualized from a general perspective and requirements from the side of employees and customers are defined. Afterwards, the *measure* phase deals with the definition of key performance indicators (KPIs) to assess the current process performance. Subsequently, the project team analyses the problem causes, i.e. the failure to meet the expectations of customers and employees in the *analyze* phase. Based on these insights, suggestions to overcome process weaknesses are generated in the *improve* phase. Finally, in the *control* phase, the effectiveness of the implemented improvement proposals is reviewed (e.g. Magnusson et al., 2004; Pande et al., 2014). To create the aspired results in the aforementioned phases of the DMAIC cycle, a large variety of quality techniques can potentially be applied (e.g. Ishikawa Diagram, Failure-Mode-and-Effect Analysis) (cf. Dale and McQuater, 1998; Meran et al., 2013; Pande et al., 2014; Uluskan, 2016). In this respect, literature also introduces the so-called “7x7 Toolbox”, which is a collection of 49 quality techniques that are suggested to be used for conducting Six Sigma projects (cf. Magnusson et al., 2004; Niñerola et al., 2019).

In this research, we focus on the Six Sigma approach for the following reasons. First, Six Sigma is a highly structured approach that organizes improvement projects along the phases of the DMAIC cycle and each quality technique creates certain results that are further processed in later project stages (cf. Antony, 2004). This structuredness of the approach is often mentioned as a major advantage of Six Sigma in literature (e.g. Antony, 2004; Bamberg et al., 2007; Snee, 2005; Zu et al., 2008). Second, Six Sigma promotes the importance of statistical data analysis and decision-making based on data (cf. Antony, 2004). This makes Six Sigma an appropriate quality management approach for industry 4.0 scenarios, in which data is continuously generated and processed, e.g. via cyber-physical systems (Foidl and Felderer, 2016; Lee et al., 2013; Sony et al., 2020; Yadav et al., 2020). Third, recent studies indicate the wide dissemination of Six Sigma in practice (cf. Antony et al., 2019; Clochet et al., 2020; Harmon and Garcia, 2020), which underlines its relevance for quality management efforts nowadays.

2.2 Smart Services

According to *Gavrilova and Kokoulina* (2015), there is no generally-accepted definition of the term “smart service”. Following *Pöppelbuß* (2020), smart services are digital services that take advantage of the increasing equipment of technical systems with information and communication technology as well as sensors and their digital interconnectivity, which is realized via the internet or other communication networks (Internet of Things). *Kagermann* et al. (2015) define a “smart service” as the needs-based provision of a combination of internet-based and physically-delivered services. *Geisberger and Broy* (2012) summarize that smart services can be perceived as socio-technical systems that comprise a combination of sensors, actors, embedded systems, digital networks, internet services as well as management processes (cf. Wellsandt et al., 2017). The principal functioning of a smart service is as follows (cf. Anke and Krenge, 2016): an interconnected device that is equipped with a sensor sends data about its condition via the internet using machine-to-machine communication (M2M) (Wellsandt et al., 2017). The communication between the technical device and the cloud or server is enabled by the internet and the users interact with the smart service with the help of mobile apps or web applications (Anke and Krenge, 2016). Considering these definitions, the complex nature of smart services becomes obvious. Hence, smart services can be characterized as bundles of “physically-delivered services”, “digital services” and “physical elements (sensors or devices)” (Neuhuettler et al., 2017). An example would be a smart senior care service, whereby a smartwatch (physical element) registers anomalies to indicate that an elderly person might have fallen (Neuhuettler et al., 2017). With the help of data analyses, the ambulance is alarmed (digital service) and immediately comes to help (physically-delivered service) (Neuhuettler et al., 2017).

Whereas quality models for each of these elements – "physically-delivered services" (Parasuraman et al., 1988; Seth et al., 2005), "digital services" (Cristobal et al., 2007; Santos, 2003) and "physical elements" (Garvin, 1984) – exist, current approaches are rather "stand-alone" solutions and lack an "integrated" and holistic perspective of the quality of smart services (Neuhuettler et al., 2017, p. 310). Accordingly, smart services have not yet been at the center of quality management research and quality concepts are rather scarce (e.g. Vinodh et al., 2020). An exception is the framework for measuring and managing smart service quality for smart senior care services proposed by *Neuhuettler* et al. (2017). The framework comprises the dimensions of "elements of smart services" (physically-delivered service, digital service and physical element) and service dimensions that are structured according to the components "potential", "process", "outcome" (Donabedian, 2003) as well as the "business model" (cf. Neuhuettler et al., 2017). Nevertheless, the authors accentuate that the framework does not represent a universal solution but rather should be seen as a starting point for an individual conceptualization of quality solutions for smart service offers (cf. Neuhuettler et al., 2017). As previously mentioned, "smart services" are applied for diverse purposes in different branches such as logistics (smart transport and mobility services), healthcare (smart healthcare services), production (smart production services) or financial services (smart financial services) (Acatech, 2016; Beverungen et al., 2017; Ravi and Kamaruddin, 2017). To narrow the scope and consider the branch-specific peculiarities more precisely, we focus on "smart production services" hereafter, and hence the use of smart services in production settings (e.g. Acatech, 2016; Anderl, 2014; Hänisch, 2017).

3 Methodology

The research project follows the Design Science Research (DSR) paradigm (cf. Hevner et al., 2004; Peffers et al., 2007). Thereby, our study is motivated (cf. Peffers et al., 2007) by the current lack of quality management methods for smart production services (cf. Neuhuettler et al., 2017; Sony et al., 2020; Vinodh et al., 2020). To contribute to closing this gap, we refer to the commonly-known Six Sigma method, which is well-established in practice (cf. Harmon and Garcia, 2020).

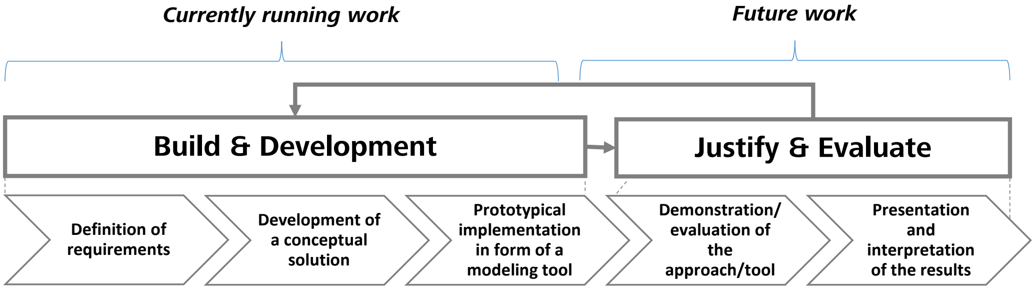

Figure 1. Procedure of the research.

Figure 1 provides an overview of the research procedure, which is structured according to the major phases of "build and development" as well as "justify and evaluate" (cf. March and Smith, 1995). Our current efforts focus on the "build and development" stage. Hence, in a first step, requirements of a Six Sigma approach for smart production services are defined. Based on these, our approach is designed as a conceptual solution (step 2), before it becomes prototypically implemented as a modeling tool (step 3). In the upcoming steps, the Six Sigma approach and the modeling tool will be subjected to a demonstration and evaluated at selected practice partners of different size (cf. Hevner et al., 2004).

4 Definition of Requirements

In order to derive a Six Sigma approach for smart production services and a supporting modeling tool, it is necessary to establish general requirements on constructing methods such as "consistency" or “adequacy” (cf. Brinkkemper et al., 1998; Greiffenberg, 2003b) as well as specific requirements with respect to each phase of the DMAIC cycle (e.g. Snee and Hoerl, 2003).

Thereby, general requirements on method construction have been introduced by *Greiffenberg* (2003b), for instance. They were collected with the help of a comprising literature review and grouped to the classes of “consistency”, “completeness” and “adequacy” (cf. Greiffenberg, 2003a; Greiffenberg, 2003b). These requirements along with the mentioned classification have proven as useful in research and practice alike (e.g. Baumöl, 2008; Brinkkemper et al., 1998; Greiffenberg, 2003a; Johannsen, 2013). Given that an in-depth introduction to each requirement is not possible within the scope of this paper, instead the specification of the requirement of *“consistency in the procedure model”* (cf. Brinkkemper et al., 1998; Greiffenberg, 2003a) is exemplarily explained for the purpose of our study. Hence, this requirement deals with the logical arrangement of activities to be performed in the aspired Six Sigma approach for smart production services (cf. Greiffenberg, 2003a). The logical sequencing of activities (e.g. definition of KPIs, etc.) has to assure that the input information required by an activity has been created in prior steps and thus is available when needed (cf. Brinkkemper et al., 1998). For instance, customer requirements have to be specified at first *(e.g. via the activity “specification of customer requirements – critical-to-quality (CTQ) factors”)* before KPIs can be defined *(e.g. via the activity “definition of KPIs”)* to measure the degree to which these expectations are currently fulfilled.

In order to derive specific requirements, the main tasks of each phase of the DMAIC cycle were identified. Considering the *define* phase, literature mentions the following major activities, for example (cf. Antony, 2006; Evans and Lindsay, 2014; Meran et al., 2013; Pande et al., 2014; Pyzdek and Keller, 2014): (1) “visualization of the process”, (2) “definition of critical-to-quality (CTQ) factors”, (3) “definition of critical-to-business (CTB) factors”, (4) “prioritization of CTQ and CTB factors” and (5) “creation of a project charter”. Overall, we came up with nineteen primary activities across all phases of the DMAIC cycle that characterize a Six Sigma initiative. To derive specific requirements for our Six Sigma approach for smart production services, each task was itemized considering the inherent elements of a smart production service, namely “physically-delivered service”, “digital service” and “physical components” (cf. Neuhuettler et al., 2017).

No.	Requirements	Description
G1	Consistency in the procedure model.	A logical sequencing of the procedure model ensures that the input information required by an activity has been created in prior steps and thus is available. For instance, customer requirements must be specified before KPIs can be defined to measure the degree of goal achievement (cf. Greiffenberg, 2003a).
...		
D1	Visualization of the smart production service by help of a modeling technique, which differentiates between the singular smart service elements and highlights the actors and resources interchanged.	A technique that differentiates between humans, machines/sensors (physical elements) or software applications, which are involved in process execution and provide input to the process (e.g. data, information, etc.) is required. Considering this, the output or input should be specified on whether it has a tangible (e.g. physical components, documents) or intangible character (e.g., data, information). More, the receiver of the output needs to be specified (e.g. customer, service employee/service provider).
D2	Definition of CTQ and CTB factors and assignment to corresponding smart service elements.	For a CTQ (customer need) or CTB (employee need) factor, respectively, it should become clear whether it refers to the “physically-delivered service”, the “digital service” or the “technology/physical element” (e.g. Neuhuettler et al., 2017). The CTQ and CTB factors determine the project goals.
...		
M4	Visualization of data interchanged in the smart production service setting.	The data exchanged/information flows in the smart production service setting should be visualizing. Further, an assessment of the data quality in terms of “correctness”, “completeness”, “topicality” and “consistency” should be enabled (cf. Klier, 2008).
...		

Table 1. Exemplification of requirements on the Six Sigma approach

Table 1 exemplarily provides selected requirements. The listed specific requirements were defined for the *define* (D) and *measure* (M) phase. A more extensive overview of the requirements specified hitherto as well as the aforementioned key activities of a Six Sigma initiative is provided at *https://tinyurl.com/yy7qwjbo*. These requirements primarily focus on the "modeling language" building block of the AMME (Agile Modeling Method Engineering) approach (cf. Karagiannis, 2018). Different reports – using the information captured in the model instances – to reflect the quality of a smart production service from different angles will be defined considering the "mechanisms" building block along with guidance regarding the "modeling procedure" in upcoming steps (cf. Karagiannis, 2018).

5 Development of a Conceptual Solution and Prototypical Implementation of the Modeling Tool

Generally, the operationalization of quality management methods is undertaken with the help of quality techniques (cf. Dale and McQuater, 1998; de Mast, 2004; Johannsen, 2011). In this respect, the quality techniques guide the creation of results in each activity of a quality method's procedure model (cf. de Mast, 2004; Gutzwiller, 1994). However, quality techniques differ regarding their "ease-of-use" or "flexibility", among others (e.g. Hagemeyer et al., 2006; Thia et al., 2005), and hence it is challenging to offer general recommendations on the quality techniques to be applied in projects. For our research, quality techniques that have proven beneficial in the authors' long-term cooperation with practice in the field of Six Sigma (cf. Johannsen et al., 2015) – e.g. CTQ/CTB Matrix (Meran et al., 2013) – were selected with respect to the identified Six Sigma key activities as well as requirements in Table 1. Accordingly, a "roadmap" (cf. Dalkir, 2005) resulted, which is a logical arrangement of quality techniques that guide the user in the elicitation of tacit process knowledge (cf. Seethamraju and Marjanovic, 2009) and the creation of improvement suggestions. The selected quality techniques were then adapted and transformed into model types with their corresponding metamodels to prepare the ground for the implementation of the modeling tool with the help of a metamodeling platform. In this regard, the model types help to purposefully document, analyze and process the results achieved (cf. Anaby-Tavor et al., 2010). Figure 2 shows examples of the metamodels created for the model types *"CTQ/CTB Matrix Model for smart production services (Smart PS)"* and *"Data Assessment Model for Smart PS"*. Further, exemplary model instances are shown in Figure 3.

Thereby, the "*CTQ/CTB Matrix Model for Smart PS"* deals with the collection of employee and customer requirements, their condensation to core statements, the derivation of CTQ/CTB factors and their alignment with the aforementioned smart service elements (e.g. physically-delivered service, digital service, etc.). Hence, it becomes obvious whether the customer and employee requirements cover all elements of the smart production service equally (Table 1 – D2). In the instance shown in this metamodel, the CTQ and CTB factors (e.g. *"reduce time between problem occurrence and repair works to 60 minutes"*) solely focus on the "physically-delivered service" (e.g. maintenance works for an elevator) (see red marker 1). These goals were derived from an analysis of wordily-uttered customer and employee expectations, so-called "voice of the customer (VOC)" and "voice of the business (VOB)" statements (cf. Pande et al., 2014). Moreover, the *"Data Assessment Model for Smart PS"* allows linking the processed data to corresponding process steps and their sender/receiver (see red marker 2) along with an initial data quality assessment (Table 1 – M4). A more comprising description of the example can be found in the supplementary material at *https://tinyurl.com/yy7qwjbo.*

Until now, seventeen model types to cover the aforementioned general and specific requirements have been designed and implemented, whereby an overview is provided at *https://tinyurl.com/yy7qwjbo.* The model types are loosely coupled with one another, i.e. the holistic metamodel of our Six Sigma approach is decomposed into singular sub-metamodels for each quality technique (model type) (cf. Fill et al., 2015). In this regard, the concepts of a smart service – as outlined in the above definitions – are integrated as classes into the sub-metamodels. For instance, for the *"CTQ/CTB Matrix Model for Smart PS"*, it is decisive whether the posed requirements affect the "physically-delivered service", the "digital service" or the "physical components" of a smart service (Neuhuettler et al., 2017). Classes representing these smart service elements have thus been defined for the corresponding metamodel. For the *“Data Assessment Model for Smart PS”*, the communication actors/components (cf. Anke and Krenge, 2016) are summarized in form of the classes of “machine/sensor”, “software/application” and “human”.

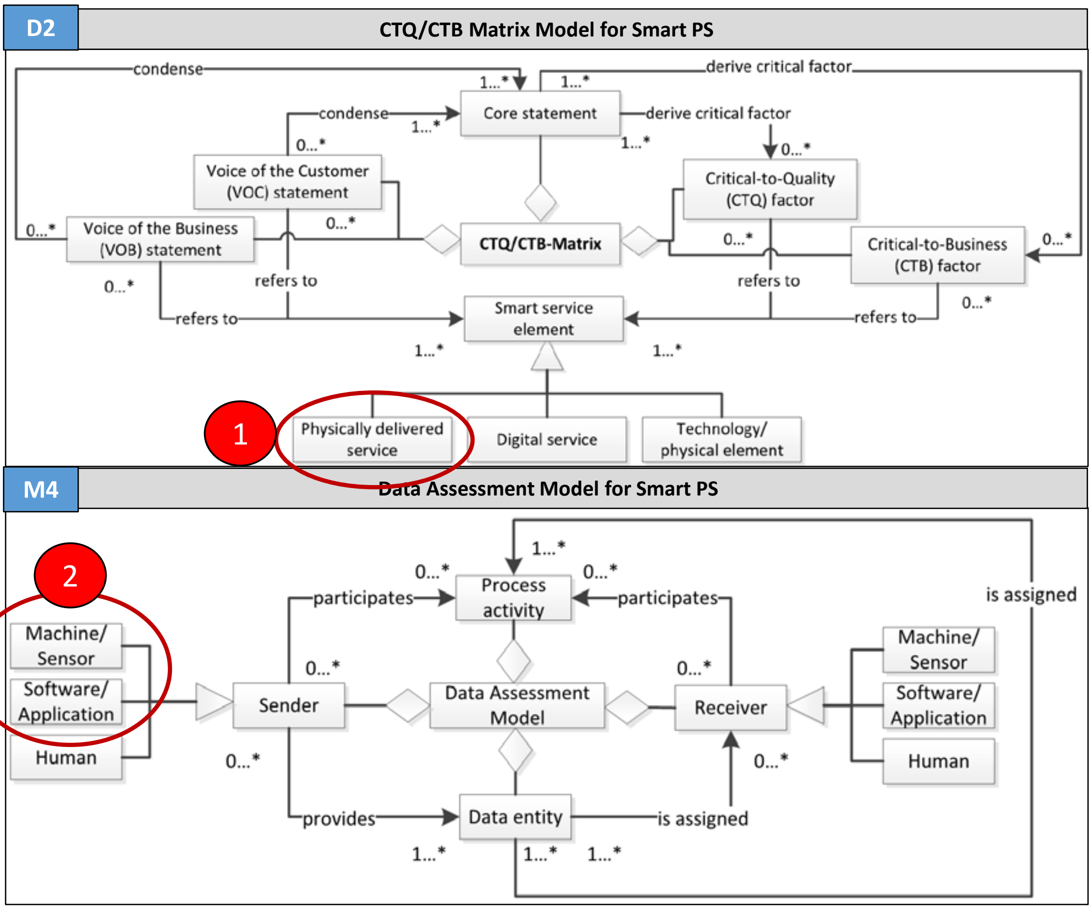

Figure 2. *Exemplary metamodels*

A first version of the modeling tool was realized via the freely-available ADOxx metamodeling platform *(adoxx.org)*. Thereby, the ADOxx metamodeling platform builds on a database-driven, multi-user, client-server repository (Fill and Karagiannis, 2013). In our modeling tool, the selection of model types for a project situation is determined based on criteria such as the “goal”, “ease-of-use” or “flexibility” of a technique, among others (cf. Johannsen, 2020; Johannsen et al., 2015). A corresponding algorithm to support users in choosing an appropriate model type for their improvement project – with the help of a graphical user interface (GUI) – is currently being developed.

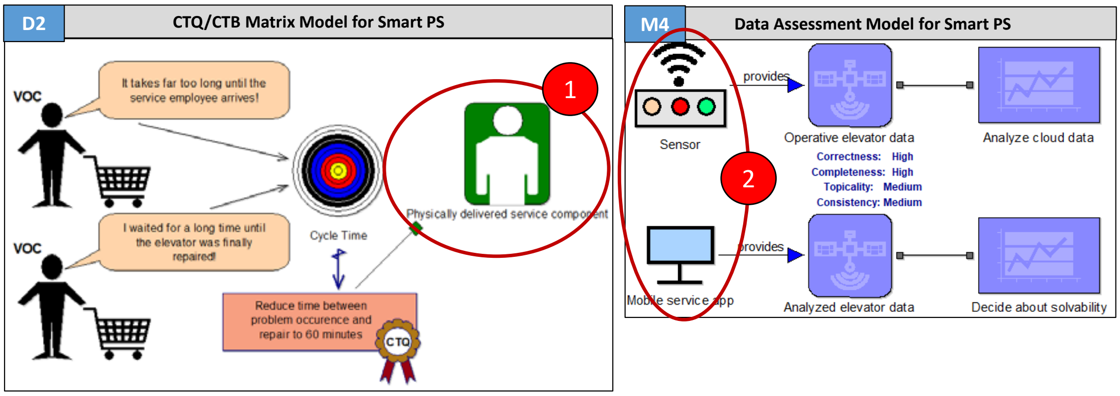

Figure 3. *Exemplary instances of the metamodels (excerpts)*

6 Significance of the Research

Our research-in-progress paper addresses an under-researched topic in quality management literature, namely the quality of smart production services. To date, operational quality management methods for smart services in "industry 4.0" settings are largely missing (cf. Neuhuettler et al., 2017; Sony et al., 2020). We contribute to closing this gap by specifying the established Six Sigma approach for smart production services and hence provide an instrument to conduct respective projects. Accordingly, we engage in a lively discussion about the design of quality management methods for the "quality 4.0" era (Sony et al., 2020; Vinodh et al., 2020).

First, we propose a set of requirements for a Six Sigma specification for smart production services and provide beneficial insights for the further development of the method. In this way, we open up a new application field for Six Sigma as current research primarily focuses on its usage for production, service or software engineering processes. Thereby, the integration of Six Sigma and industry 4.0 has been recognized as a vibrant field of research (Antony et al., 2019). Our requirements were derived by critically scrutinizing the current body of knowledge regarding the quality of "physically-delivered services", "digital services" and "physical components" (cf. Neuhuettler et al., 2017). It becomes evident that smart service quality can be viewed from different perspectives, which results in various quality dimensions that need to be considered. These insights were integrated to formulate requirements affecting each phase of the DMAIC cycle equally. Second, we show how our approach can be operationalized with the help of metamodels that prepare the ground for the technical implementation as a modeling tool. In this regard, a set of conceptual model types was developed to codify emerging knowledge during the application of the proposed Six Sigma approach. With conceptual modeling, an established concept of the IS development discipline (e.g. Anaby-Tavor et al., 2010) was transferred to Six Sigma research, which has not yet dealt with the question of how to codify, document and communicate knowledge in detail (cf. Johannsen and Fill, 2014). Third, we introduce a running prototype to be applied by practitioners to improve smart service offerings straight away. The prototype supports the codification, communication and further processing of results within an enterprise but also across company borders. Beneficial reports can be designed automatically and the data captured in model instances can be accessed by all project participants of an initiative due to its implementation as a client-server solution. By structuring the approach according to the phases of the DMAIC cycle and the provision of techniques that integrate the elements of "physically-delivered service", "digital service" and "physical elements" (Neuhuettler et al., 2017), the tool "guides" users when improving smart production services.

7 Outlook and Next Steps

The research deals with the development of a Six Sigma approach for smart production services. In addition to a conceptual solution, a modeling tool is prototypically implemented that enables the use of the approach straight away. However, while the prototype has been implemented as a first version, its application and evaluation at companies still has to be undertaken. The same holds true for our concept of the Six Sigma approach. Until now, the applicability of our solution was assessed with the help of use cases deduced from publicly-available sources only (e.g., Acatech, 2016). As a further limitation, the general and specific requirements were derived from literature and our own Six Sigma projects (cf. Johannsen et al., 2015), while completeness cannot be guaranteed. However, our promising intermediate results encourage us to pursue this research. In a next step, the Six Sigma approach and the prototype will be subjected to a demonstration and evaluation (cf. Peffers et al., 2007) at selected cooperating companies. For this purpose, we are currently in discussions with different practice partners engaged in the field of manufacturing. In a series of workshops, real-life smart production services will be analyzed and improved with the help of the developed Six Sigma approach as well as the prototype. This will also include a usability study of the prototype, e.g. with the help of the SUMI (Software Usability Measurement Inventory) approach (cf. Kirakowski and Corbett, 1993) to receive detailed suggestions on how to further develop the modeling tool.

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