Optimising Value Creation in Service System Design: Digital Twin of the Organisation for Customer Journeys

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***Abstract*—This paper focuses on optimising value creation and co-creation in service-based, interaction-oriented applications using digital technologies like digital twins. Digital technologies play a crucial role in enhancing customer experiences, improving service quality, and streamlining processes in service systems, making it essential to systemise value creation in service systems. Previous efforts have focused on digital transformation and service design but neglected the role of human activity. This contribution addresses the utilisation of digital twins for managing digital and person-based services in traditional sectors, offering a unique perspective on optimising value creation in interaction-oriented service systems. The solution involves leveraging the Service-Oriented Activity System methodology to enhance the value of digital twins by considering their characteristics in service design and optimisation.**

***Keywords*—digital twin of the organisation; insight engine; customer journey representation; value of digital applications; service-oriented activity systems.**

I. INTRODUCTION

Digital technologies and digitalisation of processes provide opportunities for new ways of value creation. However, to fully exploit the potential of this approach, the perspective must be shifted from a company-centred view to service systems in ecosystems [1] [2]. This concerns service design that must explicitly take value creation into account [3] [4]. Service systems have been defined as value creating "configurations of people, technology, value propositions connecting internal and external service systems, and shared information." [5].

Currently, the main framework to describe the creation of value creation in service systems is Service-Dominant Logic (SDL) [6]. However, once the interaction between digital services and human actors becomes more intense, human action must be included in the consideration. In this respect, Activity Theory (AT) has proven its strength in describing tool-mediated systems of collaborating actors, which includes the interaction with technologies [7]. Recently, a synthesis of SDL and AT has been suggested that connects the strengths of both approaches to deal with systems that are characterised by close interaction of digital technologies and human actors. This synthesis, called Service-Oriented Activity Systems (SOAS), describes how service systems and human actors work together to optimize the value created in service-based applications [8].

In this paper, we will show how the SOAS framework supports service design in enhancing the value creation opportunities of digital technologies as means of human action beyond simple automation of activities and make use to the specific strengths of digital service systems. We will apply SOAS to the concept of Digital Twins of an Organisation (DTO), which is a more recent development [10]. As one possible application of DTO, this paper will examine the support of service management processes [9]. We will demonstrate this using the example of the digital twin of an organisation. Digital twins have been successfully applied in various fields [11].

For related work, we can to Meierhofer and West [12] who have shown that digital twins can serve as data providers and enablers to increase the value creation in service systems. Recently, Bart et al. [13] have presented another framework for designing value creation through digital twins, which does not go back to theories like SDL or ST and presents a rather empirically oriented framework. Wagner and Cozmiuc [14] have argued that digital twins are a suitable addition to new technologies such as extended reality. Woitsch et al. [15] have pointed out that simulation with digital twins help estimate the impact of specific decisions and, thus minimise the risk.

This paper is based on a case study in which a DTO tool is developed for a service organisation in the quality management sector. [16] The entity for which the DTO has been developed is the set of all Customer Journeys (CJ) conducted by the service recipients. The central questions to be answered by applying the SOAS framework: How can DTO enhance the value creation for the management that operates with it? How is the service system to be designed to make use of such value creation opportunities? This application is also a test for the SOAS framework how well value creation in the design of such a service system can be supported.

The paper is organised as follows. Section II describes the details of the case study on which the investigation is based. Section III summarises the central features of SOAS in terms of service and activity coordination. In Section IV, we apply the SOAS framework to the case of the DTO elaborating the 5 value dimensions described by SOAS and concretise them individually. Finally, in Section V, we discuss the findings

and insights gained from applying the framework to derive indications for further use.

II. Case Study — Service Sector

The case study, to which this investigation refers, is related to a Swiss service company offering trainings and certifications. Their offerings consist in traditional offline services which are more and more complemented by digital services. Labour costs that make up more than 80% of the total costs are crucial factor, which makes digitalisation attractive, in particular if it supports the customer relationships. Since the traditional services are already largely individualised, the introduction of additional digital services leads to even more complex customer interactions. This investigation focuses on a DTO that encompasses the existing CJ associated with the company. The aim is to systematically design the digitalisation that is related to the introduction of these tools. Details can be found in [9].

A. Customer Journey

The concept of CJ refers to the processual and experiential aspects of service processes from the customers' perspective as they become manifest in the data that report the interaction with customers (e.g., emails, conversation notes). The CJ encompass various types of interactions resulting in specific customer experiences that are described as touchpoints [17].

The systematic management of CJ supports sales and quality of customer services by using information of previous interaction with customers as well as information about these customers from external sources. It aims at detecting shortcomings in the customer processes and at preparing future interactions. Main data sources are a Customer Relationship Management (CRM) system for internal information and commercial third-party databases for external information.

As we will show in the following, the straightforward approach of management only addresses the surface of customer interaction and does not take advantage of the full potential of digitalisation.

B. Digital Twin of an Organisation

Digital Twins of an Organisation (DTO) are inspired by digital twins in industrial engineering, where they support production and other processes [18]. Digital twins are virtual representations of physical objects or settings that allow for a bidirectional information flow between digital and physical constituents [19]. Digital twins stand out due to their information aggregation, real-time capabilities and visualisation that support human decision making. The core idea of DTO is the transfer of this concept to organisational settings [20].

The special challenge of DTO lies in the fact that they describe sociotechnical systems with open and often unclear boundaries. However, the complexity of today's CJ requires tools like DTO that provide a high degree of information aggregation and a comprehensible visual interface.

For the further consideration, it is important to also have a look at the DTO architecture. Generally, one distinguishes 5 layers in DTO [21]: (1) data collection, (2) data processing, (3) model-based data aggregation, (4) analytic processing, and (5) visualisation. For the current case, layer (4) and partially layer (2) have been realised by an insight engine that we present in the following. In contrast to a traditional digital twin, the data collection layer (1) does not consist of sensors, but it receives data from the company's CRM system and external sources. The complexity of data for the DTO does not consist in their mass but in their heterogeneity due to the various nature of sources and the fact that they are mainly textual.

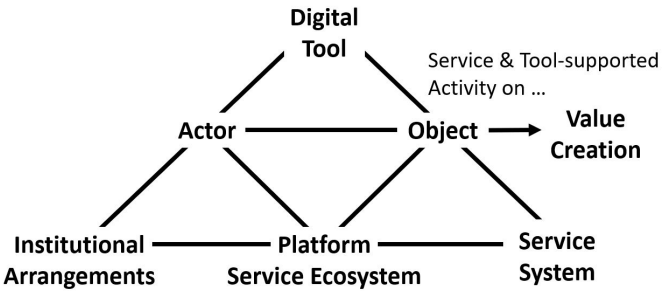

Fig. 1. Overview of the SOAS framework according to Riss et al. [8].

C. Insight Engines

We have used the insight engine of Squirro [22] for the implementation of some of the mentioned layers and tightly integrated the insight engine with the DTO. The analytic services of the insight engine support text mining und structuring. The engine is also open for using knowledge graphs and machine learning. In addition, it is used to access external data sources that are processed by its analytical services.

Through an API to the company's CRM system, it is also possible to get access to internal data. In this respect, the insight engine also implements the data processing layer. With its variety of services and processing pipelines, the insight engine is ideal for processing textual data.

III. Service-oriented Activity Systems

The SOAS framework has been developed to explore the interplay of digital services and human activities in terms of value creation when actors use specific digital tools to achieve their goals. [8] The framework describes in which way such tools interact with a service system and how the interaction with the service system creates value for the actor. The general structure of SOAS is depicted in Figure 1.

Human actions are generally related to an object upon which the actor performs the action. The object is thoroughly relevant for the actor. The interaction can also happen within an organisation for which the actor is working. Both objects and tools can interact with digital services. Central questions that the framework addresses are how the value creation for an individual actor can be increased in the service system and what this means for the service system and the digital tool.

As long as human activities and services can be clearly separated, we can treat the activity and the service system

separately. In cases, in which the human action significantly interferes with the digital services, this separation does not work any longer. These cases increasingly gain relevance as the interplay of human action and digital services becomes more and more important. The growing importance becomes manifest in the increasing number of smart applications, in which human activities and digital services are tightly linked to generate value [23]. Therefore, smartness is a clear indicator for digital tools that require a joint approach.

We will use the term smart in contrast to the term *intelligent* for applications with significant user interaction, that is, not for autonomous applications. In this sense, user recommendations in online shops are smart while autonomously driving vehicles should be mainly regarded as intelligent when they use artificial intelligence to move around without a human driver. Against this background, the SOAS framework is applicable to smart application but not necessarily to intelligent applications.

To address both digital service and activity-related aspects of value creation, the SOAS framework has been derived as a synthesis from Service-Dominant Logic (SDL) [24] and Activity Theory (AT) [25]. The connection between the two perspectives is the value creation, which is attributed to the service beneficiary in SDL and to the actor in AT. SDL describes value co-creation as the result of the integration of resources provided by several services whereas in AT value creation is related to the successful accomplishment of human action [26].

At the centre of SOAS, there is the actor who uses information provided by services to achieve a specific objective. This centrally concerns decision making, which mostly depends on evaluating existing information. The target upon which the actors intend to act mostly appears to them as an object. This focal object can be any artefact or organisational component that is of interest and needs to be acted upon. Examples are production systems or organisational processes. Action on the focal object is expected to produce some value for the organisation. In the example of a production system, the action can consist in maintenance activities that prevent costly downtimes.

While tools are under the control of the organisation, services that support the action are mostly provided by external partners. These partners are organised in a service ecosystem that is related to a service system, which allows the access to individual partner services. The service must support the distribution of tasks among the available services so that more complex tasks can be performed. The service system also requires a digital platform that gives service users access to all services in the ecosystem and supports their combination. Moreover, the interaction of services is mediated by agreements about the use of service interfaces that ensure that the individual service components work together.

Finally, the handling of service systems requires human actors who control the service system and are supported by tools that are designed to fit to the respective activities. To this end, actors need tools that reduce the complexity of the available service systems. The value created depends on how well tools support the human coordination of available services.

IV. Application of the SOAS Framework

SOAS suggests 5 dimensions that contribute to the value generation by digital technologies: Dematerialisation, Objectification, Servitisation, Platformisation and Institutionalisation. They start from the user activities and enhance them by digital services to create value by integrating additional resources (e.g., services) made available in the ecosystem [27]. In the following, we contextualise these dimensions for the case study and point out the meaning for the development of the service system around the DTO. We will investigate these 5 value dimensions for the DTO used in the current case study.

A. Dematerialisation

The idea of dematerialisation (DEM) goes back to [28] and describes the separation of information from the material object that produces this information. In the current case study, the challenge consists in defining the proper material object because the object consists in the collection of CJ, an object that cannot be measured by sensors.

The major feature of a DTO is to replace sensor data by information that determines the process to be observed. This includes emails, phone notes, tasks produced in the process (in the current case mostly accessible from a CRM system) as well as information from external sources such as commercial newsfeeds or company data bases. The aggregation level is higher in this case compared to sensor data in a machine whereas the volume of data is lower. The major task consists in associating such information with the respective CJ.

The value resulting from DEM consists in bringing together various sources of information related to the CJ in real-time. This also concerns the presentation of the DTO which can be augmented by such information immediately on the actor's request. For the CJ, the open boundaries of the system represented in the DTO are important since the inclusion of external information sources provides insights that might not be comprehensible from an insight perspective only.

B. Objectification

Objectification (OBJ) refers to the fact that human comprehension and action is usually directed towards an object [29]. Whereas DEM leads to a breakdown of the object structure and a disintegration into a plethora of informational bits, OBJ aims at reuniting this information for the purpose of human sensemaking and intervention. It is not only that information is physically integration (e.g., in a large number of diagrams of a dashboard) but also logically by establishing semantic relationships between pieces of information. DT can be seen as the most obvious incarnation of OBJ and it is not surprising that the idea of DT directly follows servitisation at its heels [30].

The current DTO expresses various relationships between pieces of information. Primarily, it provides a temporal order that helps identify causes and effects. Secondly, information is

organised per customer, which opens other aggregations such as for business or regional sectors. The multitude of different aggregation makes it necessary to allow for specific views of the object that still serves as common reference point of all these views.

The value that results from OBJ is to make it easier for human actors dealing with the DTO to faster comprehend features. Patterns can be identified more easily if the individual clues that make up this pattern are not too dispersed. Thus, the DTO improves the actor's comprehension of the CJ by providing a coherent object which the actor can explore through different views. This accelerates the actor's comprehension of different situations and leads to faster and less error-prone decision making.

C. Servitisation

Servitisation (SRV) describes the decomposition of a service system into interacting service modules [31]. While DEM only enhances the accessibility of information, SRV improves the processing of this information by flexibly employing a variety of services to enhances the informational content provided to the actor. Services can aggregate information according to specific rules or they can identify patterns in complex ensembles of data. Services can involve other actors, who contribute to the execution of a task by their specific expertise.

In the case study, the external information sources can be regarded information services provided by third parties. However, it is not only the raw information that is provided by the service included in an insight engine [23]. Hereby, the mass of available external data is aggregated according to the purpose of analysing the CJ. For example, this might concern questions regarding the market environment of a particular customer or group of customers.

The value of SRV in the DTO consists in making further information processing available in an instant. Services that utilise external data source enhance the information provided for the CJ. They do not only add this information to the visual DTO, but they help analyse the interaction with the customers. For example, it is possible to look for specific occasions that happened to a customer or their sectors during the CJ and can explain why customers took certain decisions reflected in the CJ.

D. Platformisation

According to Poel et al. [32], a platform is a "(re-)programmable digital infrastructure that facilitates and shapes personalised interactions" among actors and service providers, "organised through the systematic collection, algorithmic processing, monetisation, and circulation of data." Such infrastructure does not only enable services to work together but also allows actors to interact with these services. Platformisation (PLA) stands for the creation of access and interaction opportunities for service providers around a digital platform [33]. Such a platform must provide services and infrastructure to service providers that allow them to join the ecosystem. The central value of platformisation from the actors' perspective consists in the speed and variety of providing services that enable them to accomplish their tasks better. For example, this might include search facilities or analytical functionalities.

DTO can be understood as interfaces between the physical and the virtual world. In this respect, they make digital services available for acting upon the respective physical object. This allows actors to use the available services in a flexible manner. In the current case, the insight engine provides the Data Processing Layer for the DTO [9]. This reflects the crucial role of information retrieval for using the DTO. The platform character of the insight engine comes to the fore when one regards how it makes information available. Among other features, it gives access to a variety of commercial data bases, data analytics services and machine learning facilities. Moreover, it provides access to various internal information systems (e.g., the customer relationship management system). It also enables the use to large language models [34].

The connection between the DTO and platformisation is related to the platform's task to organise the access to the services. Which services are required depends on the part of the DTO that is analysed. For example, the actor examines a specific part of the CJ for those customers that belong to a specific sector. While the actor recognises an increased activity of customers in a certain period of time, it is possible to use context information provided by the DTO to search company data bases for news that might be related to the customers' activities. Thus, the specific section of the DTO implicitly helps to formulate a specific search and accelerates the search process. The platform offers the actor search tools fitting to the issue the actor is dealing with.

E. Institutionilisation

Institutionalisation (INS) refers to the process of establishing norms, rules, standards, meaning and even organisational boundaries that enable and constrain human action [35]. This concerns various issues regarding the CJ: Who gets control over which customer and other information? How is the payment of service use organised? How do service providers get access to the service systems or the platform? These questions must be clarified to ensure the viability of the service system.

For the CJ, a central issue is the access to external information sources. Regarding the technical side, such access is no problem, but the access is not free and it must be clarified how much the access to these data sources costs while using the DTO and whether the resulting value for the actor is large enough to justify these costs. A successful DTO that establishes a widely used digital platform can impose institutional pressure on service providers to deal with this platform [36].

The specific value of a DTO for the actor resulting from INS consists in the growing relevance of the DTO as a platform that allows to control the conditions under which services are made available. This can be related to the price of a service but also to its quality that might improve due to the competition between different service providers.

F. Synthesis of the Different Dimensions

The strategic perspective in developing a DTO for the CJ must keep in the focus the value of the DTO for actors working with it. The purpose of the DTO for the CJ has been seen in the possibility to path the way how customers interact with the company over various touchpoints.

In this sense, it is primarily an *analytical tool*. This purpose is supported by dematerialisation and servitisation which starts from the available CRM data, augments them by further information about customers provided by external data providers and analyses all information by means of an insight engine from another service provider. Other services can be included as they are needed.

The analytical component is further supported by the objectification made available by the DTO. Here, the objective is to go beyond the usual information presentation of digital dashboards towards a visual and semantically enriched provision of information in a comprehensible object. It is important that human actors mainly make sense of their environment through their visual and object-centred capabilities. Actors may decide which information they can additionally need for the analysis of the DTO. We must distinguish two different situations: (1) Actors want to make sure that the CJ is not disturbed and runs smoothly. The DTO should provide means to make this visible. (2) Actors might also face exceptional situations that fundamentally differ from their routines and require extraordinary analytical tools. These cases are usually unpredictable and often required non-standard analytical services.

Servitisation is the basic condition to provide such services but not sufficient to make them available in time. To support decision making, it has been shown that the object representation can be enhanced by advisory services that improve the quality of decision [36].

Here, platformisation comes into play. A digital platform can offer a variety of services that actors choose as they need them. However, a digital platform usually requires more than one service beneficiary to be economically viable. This means that the platform might be opened to other potential service providers and beneficiaries. In a first approach, customers and partners of the central service provider can be such beneficiaries; customers get a better insight of the service and access to related information, partners can better exchange information and get access to customer information. With this transition, the DTO becomes a *digital platform* for a variety of customers around the CJ.

V. Discussion of the Results

We have pursued two objectives in this study. On the one hand, we wanted to find out how the added value of DTOs can be increased through an associated service system and how services can be integrated for this purpose. To this end, we were able to show that DTOs should not only be understood as an analytical tool, but also offer further opportunities for value creation via the service system. A first version of the visualization of the CJ could be realised. From the first experiences the challenges of the implementation becomes clear.

(1) Dematerialisation: Whereas the access to external data proved to be easy (except for the costs related), the collection of internal data via the CRM system proved to be a challenge. Interaction often takes place verbally and is not always adequately recorded in the system. Data quality is another issue in this respect.

(2) Objectification: For the first, the visual representation of the customer journey gives users an idea of what is going on in the CJ. Selecting certain part of the CJ and applying specific filters, brings up new questions and provides new insights. Here, the challenge is rather that the opportunities are not yet fully understood, which needs more time.

(3) Servitization: The integration between the CRM system and the services provided by the insight engine works well but the idea to include more services required more integration efforts that comes at a cost. We expect this to become demand-driven in the future.

(4) Platformization: The idea that a platform can be used to access new services is not particularly strong because it is an approach that does not correspond to the usual procedures. This step required more conviction.

(5) Institutionalisation: Working in networks is already well established in the company. However, the transfer of this collaboration to a digital media is not a matter of course. New rules how to use the digital service system and the DTO must be established and this takes time.

(6) The interplay of the different dimensions is not yet understood as being natural. In particular, working with the visual DTO increases the need for support from digital services, which can be seen as a driver for greater coordination of dimensions. The integration of a platform could require the most rethinking of employees and management.

The second objective was to prove that the SOAS framework is a suitable instrument for the design of digital tools and associated service systems. The described results show that the SOAS framework can help tool and service designers in the development process by pointing out the interactions between human behaviour and the performance of service systems. Accordingly, optimization of value creation is not meant in a quantitative sense but must be understood qualitatively, i.e., that service designers must consider *all* dimensions and how they work together. A promising path forward might consist in a stepwise approach that start form the visual component and the employees' demands in working with it. It quickly becomes clear that more services mean faster and better decisions. In particular, AI-based services seem to be rather attractive in this respect. The demand for more services and information san then support the acceptance of a platform as common access point. This can be seen as the next step in this optimisation. The establishing of new rules and collaboration must happen in parallel to accompany this process. A decisive step consist in opening up the platform to other parties. Here, the value creation lies in the potential synergies with these new parties.

The focus for future development will be the closer integration of the visual CJ and the insight engine. This requires more experience of users working with the system to come up with information demands stimulated by the DTO. One particular interest is the combination of aspects of the DTO (via selected parts of the CJ) with AI-based natural-language inquiries that refer to the selected aspects. We see particular potential in this type of use.

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