Digital Servitization in Electric Power Industry

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Abstract

This proposal focuses on digital servitization in the electric power industry from an ecosystem perspective. In each section, the main concepts will be elaborated. By doing so, the significance of the topic and the need for further research will be clear. Four research gaps and their corresponding research questions are suggested as follows respectively. 1.existence of value creation and destruction among actors: What is the value creation and destruction of digital servitization among different actors in electric power ecosystem? 2. The role of new actors such as aggregators in service business models with other stakeholders: What is the role of emerging actors such as aggregators in delivering the service value to the users (customers) in different phases of ecosystem transformation? 3. Impact evaluation of service business models on users: How have service business models impacted users so far? 4. Interactions of newcomers and incumbents in the electric power ecosystem: How do service business model startups compete and cooperate with established utility companies?

Keywords

Digital servitization, Electric power industry, ecosystem perspective, Service business model

1. Introduction

In this proposal, I will introduce my research around digital servitization (DS) in the electric power industry (EPI). Digital servitization defined as the shifting from product to service-based value proposition by the help of digital technologies, has been creating new business ecosystems for companies in EPI particularly in distribution part of the value chain where most of the transformation of traditional grids to smart gids is happening [1]. During this transformation, novel technologies are introducing such as smart meters, industrial electric storage, etc., and consequently, utilizing data analytics to release the potential of new services (e.g., energy auditing, maintenance and energy efficiency improvement, energy trading) to the customers [2].

Additionally, new roles for actors are being defined (e.g., aggregators), new value creation and value destruction among companies are happening, the previous actors' role is changing (e.g., involvement of energy consumers in smart grids, energy traders) and new service business models including X as a service, marketplace and platforms are increasing.

An example of value creation[2] can be the state where the electricity suppliers are able to make the hourly price contract with the consumers and fulfill their promises and the consumers in turn show the willingness to have this type of contract rather than fixed contract. In contrast, if the companies could not deliver the benefits promised on the hourly price contract, consumers will not find it attractive, thereby not being satisfied with the service provided by the suppliers [3]. In such situation, dissatisfaction is not itself the value destruction but interpreted as a possible sing of the value destruction where the suppliers' promises did not materialize.

These changes mentioned above, make us expand our understanding about the EPI and particularly smart grids.

While the research on DS is increasing, the scope of the research has been limited to a single or dyadic perspective and therefore the ecosystem perspective and the changes thereof is neglected [4].

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[2] In this study, I consider value creation and value destruction equal to value co-creation and value co-destruction respectively.

Adopting an ecosystem lens in studying the DS facilitates the understating of new actors and their corresponding roles and unravel the complexity of challenges among the actors including interest or resource allocation conflicts. Considering the EPI, existence of specific restricting regulation for instance for peer-to-peer transactions, prosumers and energy monopoly are some of the reasons why DS has the potential to be investigated in this context through an ecosystem perspective.

In the following section, a short explanation about servitization and digital servitization will be provided followed by an elaboration on DS in EPI. Section 4 and 5, will focus on the importance of ecosystem lens in studying of DS and the significance of EPI in particular respectively. In the last section, some possible ideas for the future research will be presented.

2. Servitization and digital servitization

Servitization for the first time used by [5] who defined it as adding services such as support, maintenance and finance to products. Despite the vagueness of the evolution of servitization in the literature [6], this concept has been widely recognized to describe shifting from product to service-based value proposition [7], [8].

Servitization started from simple forms such as add-on service on products e.g., after sale services [9] and low level of interaction between the supplier and the customer [10]. Meanwhile the increasing desire for entangling service-based value in products, emergence and widespread utilization of digital technologies in social life [11] and businesses i.e., digitalization [12] have provided new opportunities for companies [13], [14], two of which are facilitating the servitization process by creating a foundation for new service-based offerings [15]–[17] and augmenting the value and experience that customers receive from products [18], [19].

Acknowledging the interrelation of digitalization and servitization [20] the convergence between these two is known as digital servitization [21]. Even, some studies, by using the word "servitization", factually refer to digital servitization by admitting the role of digital technologies as an inherent characteristic and enabler of servitization (e.g., [2], [7], [22]). In this research proposal, I adopted the term "digital servitization" since it conveys the digital characteristic of servitization.

Additional to the shifting from product to service-centric value proposition, DS by the specific help of IoT and cloud computing[23] has led to creating new business models in which what is valued by the customers is the service even if what companies have to offer is a product. In this case, the service is not the embedded part of the product, but the product is what makes the delivery of the service possible [2]. These business models can be shown as X as a service (XaaS) which X can be substituted by different things covering a vast range of business models which in various contexts have been developing [24]. For instance, data as a service (DaaS), analytics as a service (AaaS) [25], software as a service (SaaS) [26], mobility as a service (MaaS) [8], energy as a service (EaaS), battery as a service (BaaS) [22] etc.

Needless to say, these types of businesses are changing the business ecosystems particularly when growing number of startups by developing XaaS enter the competition with well-stablished companies [27].

Given that, DS and specifically XaaS are components of my research. In the following sections, by explaining a specific context, the importance of further investigation of DS in the EPI will be illustrated.

3. Digital servitization in electric power industry

Over time, EPI the same as other industries, has gone through a transformation over the past years and the effect of DS can be seen more than before specifically by presence of different types of service business models over the energy value chain from generation to consumption [2]. However, most of the emerging service business models are in the distribution of energy value chain where a large portion of transformation of traditional grid to smart grid has occurred [1].

In the beginning, the electricity produced was purchased and used by the customers without any other services in between. After a while, the number of energy service companies aiming at reducing energy-related cost by energy auditing, maintenance and energy efficiency improvement has grown [28]. Utilization of new technologies e.g., substituting meters with smart meters or even renewing them, increasing distributed energy resources e.g., microturbines, photovoltaic systems, wind systems, etc. [1] and liberalization of market in some counties [22] are some reasons why the number of newcomers as startups with service business models particularly in the form of X as a service is increasing [2], [22].

It seems; however, XaaS are not the only type of the service business models, they have been in the focus of scholars, so that even [2], represents the XaaS as the outcome of servitization without stating explicitly the role of other services including platform, service marketplace, etc. Similarly,[22] created their focal explanation about XaaS although they acknowledged the presence of other types of service business models such as marketplace and platform. They introduced 10 types of XaaS business models run by startups as the outcome of servitization. These ten types comprise “Charging”, “Software”, “Flexibility”, “Energy”, “Solar”, “Comfort”, “Battery”, “Microgrid”, “Trading”, “Heating” as a Service.

As a further step, [22] classified these 10 types into six categories based on their value proposition to the end customers. For example, comfort and heating as a service, despite the difference in their service range, both can aim for providing services related to temperature adjustment for households. Therefore, this commonality could be the reason to combine these two business models as “comfort and heating”. These six categories are comfort and heating, flexibility and trading, energy efficiency and management, solar and microgrid, charging and battery and lastly, energy software solutions.

Aforementioned study showed that the UK, Netherlands, Germany, Spain, and France are five pioneers with the highest number of startups in service business models. Moreover, Scandinavian countries i.e., Sweden, Norway, Finland, and Denmark constitute 10.3% of startups in EPI.

Figure 1 shows how distribution of service business models in each category is different. Additionally, the percentage of each type of business model in each category is specified. For instance, solar and microgrid has the largest number of startups despite XaaS and platform comprise a small portion of it. Interestingly, startups providing services related to energy software and solutions, and flexibility and trading reported as the largest XaaS and platform business models.

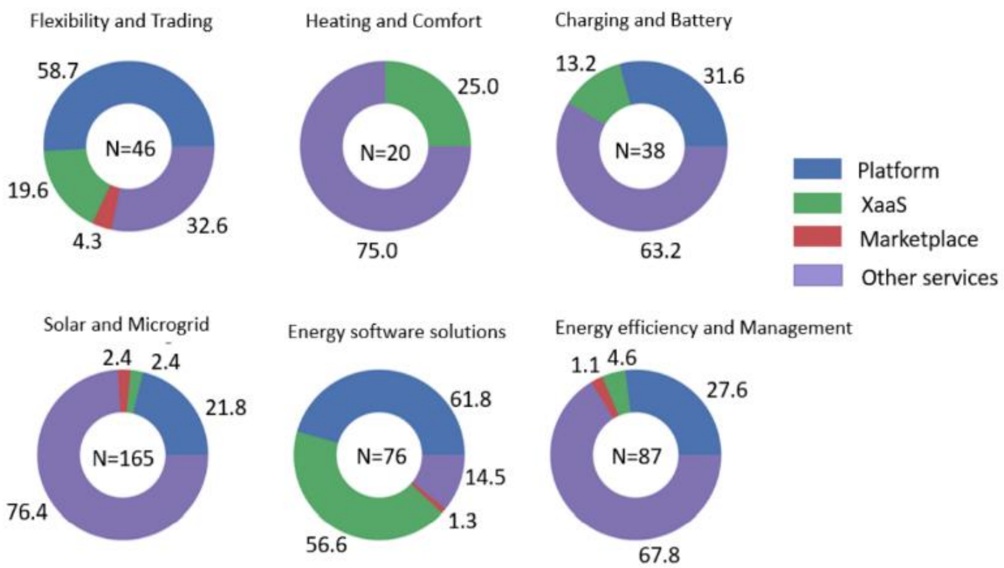

Figure 1: Distribution of various service business models in electric power industry [22]

[1] elaborates on the transformation of traditional power grid to smart grids and the corresponding explains the challenges of electric utility in smart grids as illustrated in the figure 2.

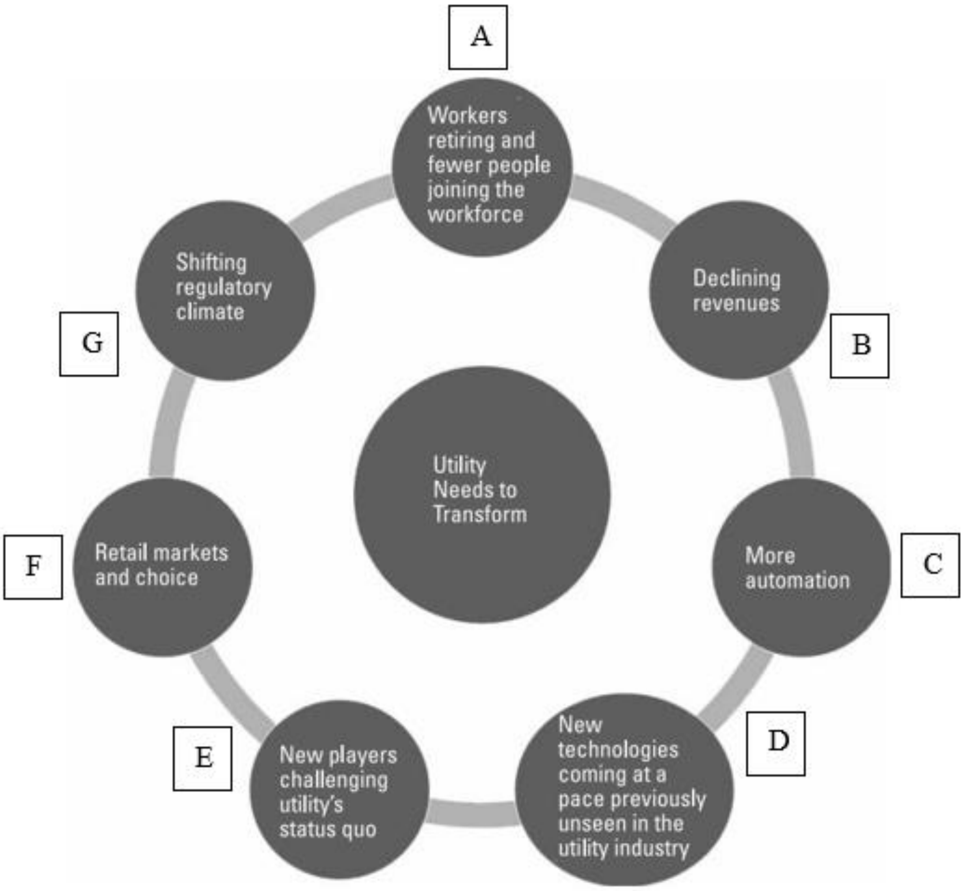

Figure2: Utilities challenges in smart grids [1]

Among these challenges, emergence of new technologies at an unprecedented pace (D), new players (E) and retail market and choice (F) are related to DS. Utilization of new technologies e.g., distributed energy resources management systems, expedites the innovation pace in power grids and changes the old paradigm where regulators and utilities controlled the environment. In the new paradigm, the utilities implement these technologies by themselves. Moreover, implantation of new technologies by customers such as solar panels and electric vehicles is increasing that oblige the utilities to respond with the proper services.

Regarding the new players, it is stated that introducing microgrids and new players such as aggregators are changing the way electricity is delivered to customers which is a challenge for utilities.

Finally, creation of retail market implies that the growth of distributed energy resources and storage, diversified the ways of creating and delivering the electricity to customers by the presence of new service providers. As a result, it gives more options to the customers to choose the retailers which endanger the utilities' monopoly and the dynamics between utilities and their consumers.

DS is one of the topics has the potential for further research in different industries particularly in EPI due to the importance thereof and the highly pace growth of DS in this sector [2].

4. Digital servitization in ecosystem

Although the convergence of digitalization and servitization opened new doors for the businesses to benefit, many studies have investigated the companies' behavior and internal elements of the companies such as business strategies, operations and capabilities which are arguably in the organizational level (e.g., [29], [30]). For instance, by adopting the dynamic capabilities perspective, [29] examined how pursuing exploration and exploitation strategies can affect the firm's attitude toward DS.

[30] described the influence of four interdependent digital technologies, including IoT, cloud computing, big data, and data analytics, on DS through the lens of business model innovation. In this

type of research, the scope has been limited to the single-firm or dyadic perspective, and the holistic picture of the DS by considering an ecosystem perspective is missing [4].

Business Ecosystem refers to the “community of organizations, institutions, and individuals that impact the enterprise and the enterprise’s customers and supplies” [31, p. 1325]. The mechanism for coordination among the actors in business ecosystems is based on non-generic complementarities without a full hierarchical control. Not generic refers to the fact that the collaboration between the companies have a specific complementarity for a common purpose so that the outcome of one actor depends on other actors’ outcome. Absence of hierarchical control means that the collaboration between companies should not be necessarily based on any formal contract or obligations [32].

These characteristics of ecosystem is one of the aspects differ ecosystem form other business constellations such as business network (ibid).

According to [33] one of the required types of research for DS is adopting the ecosystem perspective. Despite the efforts of different scholars to move from a single firm to a network approach in scrutinizing the DS [7], [30], [33]–[36], there is still room to explore the ecosystem issues of the DS.

The importance of adopting an ecosystem perspective, which obliges more exploration, can be summarized as follows:

First, the ecosystem perspective helps to have a holistic picture of companies working together to handle a business as a company is not always run alone. Through this perspective, the investigation of the interaction among firms helps to understand the possible challenges, barriers, contingencies [34] and provide an appropriate response to eliminate the issues respectively. As not all collaborations among firms lead to success thus, the cognition of the contingencies at an ecosystem level might be helpful.

Second, as DS might lead to creating new business ecosystems where the open flow of data plays a crucial role in the survival of the businesses, exploring the emergence of new actors, related functions, and services seems essential [37], [38].

Third, the collaboration between private and public sectors is one of the challenges that the new service-oriented business models have faced (e.g., in the mobility context). Digital technologies have contributed to the development of platforms facilitating the collaboration of public and private sectors. However, underlying complexities comprising non-standards application programming interfaces (APIs) [37], conflicts in allocating new responsibilities, different uncertainties, concerns and governance structure in private and public sectors [38] have complicated this collaboration.

Lastly, the involvement of private data (customers’ own data, individuals, etc.) and public data for the development of such businesses make companies consider ethics [39], privacy and security [37], [40] more than ever as one of the requirements for digital services is procurement and processing the data [41]. Therefore, an ecosystem perspective can lead to a comprehensive understanding of what DS might encounter when it comes to utilizing different types of data provided by various ecosystem actors.

5. Ecosystem of Electric power

By reading the literature of servitization whether through the ecosystem perspective or not, the focus has been on the manufacturing industries when shifting from a product to service centric view (e.g., [21], [42]). Even the premise of the studies on servitization ecosystem implies that manufacturing companies are the focal point of the servitization ecosystem.

To end this proposal, this section will aim to specify some characteristics of ecosystem of electric power which explains why DS in this ecosystem is occurring un-der certain settings that can be different from manufacturing industry. Therefore, more investigation is needed when DS is happening in EPI.

1. Regulation: Energy sector is under certain regulations [43], [44] that influence the innovativeness of the electric power ecosystem and impede the empowerment of consumers [45]. For example, despite the efforts to eliminate the technological e.g., blockchain [46] and regulatory issues of energy transactions after 2010, it is not widespread for peer-to-peer transactions to be done where individuals can trade their energy in the energy markets [47].
2. Service-based: The servitization literature, most of the attention is focused on manufacturing industries (e.g., [9], [21]). However, servitization is not confined to

manufacturers [48]. regardless of the essence of electricity as a good or service [49] the way electricity is delivered to the customers is considered as a service [2].

It means that servitization will not change the application of electricity in contrast to servitization in other context that the application of product can shift to a service. for instance, in mobility as a service business model (e.g., Uber) the value proposition is not the car as a product, but as a service aiming to provide mobility for the travelers [50].

In this example, the main value of the car is not received due to the product-based nature of it but due to the service i.e., mobility provided. In energy industry, despite having manufactures for technological part or infrastructure, servitization does not necessarily change the application of electricity but the way this electricity and the respective services can be delivered is diversified.

Therefore, the typical definition of servitization i.e., shifting from product to service proposition might not work fully in electric power context. As a result, servitization research can be conducted differently since the companies' behaviors and the practice for servitization might be different in such ecosystem.

3. Prosumers: Another aspect of the smart power grids is that the consumer alongside the consuming electricity can have the role of micro producers, which refers to the concept of prosuming [51]. According to [52] utilization of digital technologies, distributed energy resources and prosumers are the elements affecting the increasing service business models. However, the presence of prosumers in the power grids ecosystem created various challenges [53]. For instance, reaching an agreement on involvement of main stakeholders including utility companies, technology providers, energy producers and prosumers for energy sharing mechanism.

4. Monopoly: Energy monopoly is not a new topic to discuss but the competition in this monopoly to certain degree has been in the focus of the EPI specifically in the distributed part of the value chain [22]. One of the actions to make this monopolized environment competitive is market liberalization [54]. However, according to [43], it is still on debate if this action could really facilitate the liberal market to achieve its objective specifically after the radical technological improvement, changes in electricity consumer and energy transition. As a result, the asymmetry of the power in the electric power ecosystem arises many questions about the entrance of newcomers in such ecosystem and how they collaborate with well-established companies [43].

6. Research ideas

Based on what was explained in the previous sections, this proposal, offers four re-search ideas (see table 1). The first one, is the research topic that will be pursued after this proposal. Therefore, it will be elaborated in more details. The three remaining ideas might be the alternative for the follow up research in the later stages.

1. The first research will investigate the value creation and destruction that different actors in the ecosystem of EPI might counter by DS.

   In this regard, role of different technologies to mitigate the value conflict in ecosystem can be studied.

   This study will be exploratory/qualitative based on multiple case studies aiming to shed light on the degree to which the electric utility ecosystem has constructive/destructive interactions. In addition, it will specify if digital technologies can provide a better setting for such ecosystem.

   To be precise, value creation and value destruction are recognized in different approaches and show two sides of a coin that constitute an umbrella word of value formation [55]. If the value formation is in the direction of increasing the well-being among the system (ecosystem) actor(s), value creation occurs and declining in actors' well-being is referred to value destruction [56]. In the context of EPI, value creation and destruction occur in various circumstances. For instance, if the consumer' data which contains the patterns of the consumer behavior, ends up in misusing by any organization or even hackers, not only the expected services will not be delivered but the privacy of the consumers will be violated. At the same time, the reluctance of the consumers in cooperation with aggregators who carry the responsibilities associate with demand response management, flexibility market, etc., will result in a negative well-being in the whole service ecosystem. In this example, value destruction is a result of an imperfect resource integration between service provider and consumers and destruction is created by both sides reciprocally. The resources can be tangible (technology, contract, etc.,), or intangible (knowledge, service quality, etc.)

It should be noticed that value creation and destruction are not bound to business to consumers, but it can occur in business-to-business market. For example, the conflicts of interest between balance responsibility parties (BRP) and aggregators in some responsibilities can potentially lead to value destruction (see [57] for more information).

The candidate actors for collection of data will be shown in the figure 3.

Since the focus of the study will be on the customer side of the EPI, the actors who possibly can be contacted by the electricity consumers for different services are selected. However, during the conducting the study, if necessary, more ecosystem actors such as regulatory organizations or transmission and distribution system operators will be added. Suppliers as the actors who are responsible for the providing electricity contracts will be selected from different electrical areas in Sweden (S1 (Luleå), S2 (Sundsvall), S3 (Stockholm), S4 (Malmö)). The reason is that due to considerable electricity price difference among these areas, the way the value is created or destructed might be different. After selecting the suppliers their corresponding online consumers reviews will be analyzed. Two possible types of aggregators will be opted depends on the availability of these emerging actors in the Swedish electric power industry.

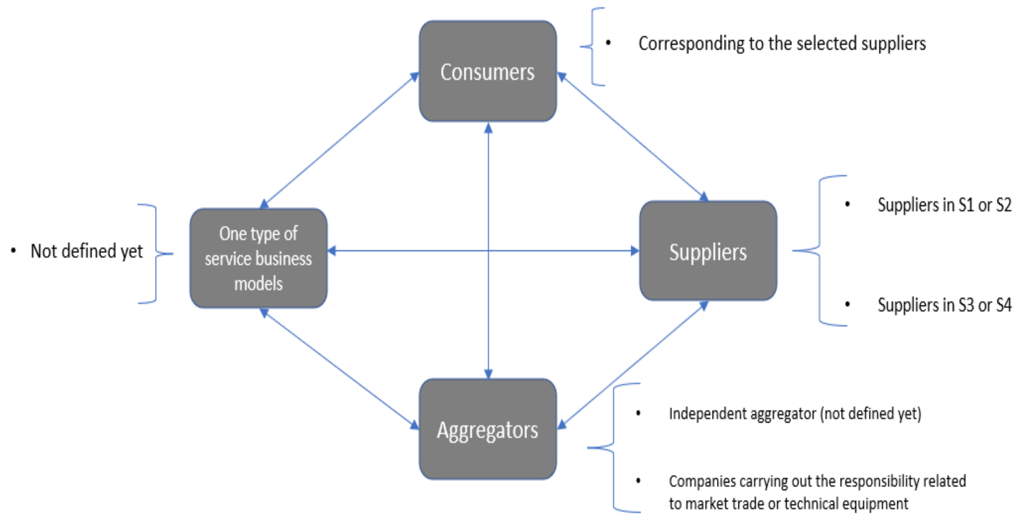

Fig. 3: Selected ecosystem actors in my research

Furthermore, one type of service business model (can be one type of XaaS but not defined for now) can be added to the ecosystem actors for this study to capture the business complexities of this ecosystem. However, the feasibility of considering all actors in one study must be determined in the further step.

The interviews with each of this business entities will be the data collection method. The result of this study can generate hypotheses that form the basis for the subsequent research.

Table 1
Research ideas based on my proposal

No.	Gap	Research question	Research design	Contribution
1	Existence of value creation and destruction among actors	What is the value creation and destruction of digital servitization among different actors in electric power ecosystem?	Exploratory/ qualitative study, multiple case studies	Clear picture of interactions that affect the electric utility ecosystem. Role of digital technologies in this regard.
2	The role of new actors such as aggregators in service business models with other stakeholders	What is the role of emerging actors such as aggregators in delivering the service value to the users (customers) in different phases of ecosystem transformation?	Qualitative case study, literature review	Clarity on formation of such actors and their business models in smart grids
3	Impact evaluation of service business models on users	How have service business models impacted users so far?	Explanatory/ quantitative	Better understanding of service business models not only as economic entities but as sociotechnical entities
4	Interactions of newcomers and incumbents in electric power ecosystem	How do service business model startups compete and cooperate with established utility companies?	Qualitative, Mulitiple case studies	Illustration of the real picture of coopetition among ecosystem actors in electric utility ecosystem

2. This research will investigate the role of aggregators in service business models and their interactions with related stakeholders by adopting a qualitative research design using one case or multi cases. The result of this study will improve the comprehension of aggregator concept in electric utility services and their responsibilities toward the rest of emerging service business models
3. This research will evaluate to what degree service business models have been successful in their goal for social benefits and explore the impact of consumers on these business models for the better implementation. This study will be quantitative based on a survey as a data collection method which draws on the result of the research 1 and 2. One of the expected contributions can be the expanding the understanding of service business models not only as economic entities but as sociotechnical entities.
4. Fourth research will elaborate on the cooperation and competition among service newcomers and the incumbents in electric utility companies. This qualitative

research contributes to depicting the nuances in coopetition among newcomers and well-established companies in electric utility context.

In total, the future research can potentially facilitate studying DS from a sociotechnical perspective, which ameliorates respective challenges thereof [40], [58], [59].

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