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The Roles of Individual Actors in Data-driven Service Innovation – A Dynamic Capabilities Perspective to Explore its Microfoundations

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Abstract

The increasing amount of data that can be collected from interconnected devices offers various opportunities for the co-creative innovation of data-driven services. It demands for the integration of traditional and new actors that have to deal with alternating roles. Using a modified Delphi method, this study takes a microfoundational view and investigates the roles and capabilities of individual actors that together shape an organization's ability to innovate. By identifying relevant activities and their relative importance in the innovation of data-driven services, the study specifies nine actor roles and their contribution to organizational capabilities. The findings indicate that technical roles are less important than those that shape mindset and strategy. The paper contributes to current research on the utilization of data for service innovation by providing a microfoundational view of individual actors that helps to account for such higher-level phenomena as dynamic capabilities.

1. Introduction

Ongoing digitization and the accompanying increase in available data affects almost every aspect of industry and everyday life. This growing volume of data – from sensors, interconnected devices and associated analytics – enables organizations to improve processes and to co-create innovative data-driven service offerings that rely on data as a key resource [8]. Data-driven services are characterized by a digital nature [61,63] and are sometimes used synonymously to other related concepts such as smart or digital services [62,63]. The core aspect of data-driven services is the utilization of data analytics for service provision [61]. Examples are services such as Rolls Royce's VisiumFUEL that allow airlines to monitor an aircraft's fuel consumption and offers possibilities for efficiency improvements or Daimler's FleetBoard service that utilizes data from a fleet of trucks for being able to offer individualized insurance premiums [68]. The utilization of data for new types of service offerings is accompanied by a set of novel challenges such as data access and ownership, the development of new revenue and business models and deeper knowledge on customer needs [2,9]. It requires the integration of multiple actors [1-3], as services are increasingly innovated across rather than within organizations, working with customers, partners and suppliers. Within these networks, connected individual actors co-creatively integrate their resources [3,59] to facilitate an organization's growth [4,5,17].

To compete profitably in today's dynamic markets, organizations need to develop the requisite capabilities to reconfigure their resources, business models and organizational structures in favor of the new circumstances [7]. In so doing, they need dynamic capabilities to sense opportunities and threats, seize those opportunities, and reconfigure both tangible and intangible assets if they are to maintain or develop sustainable competitive advantage [36, p. 1319].

Understanding these high-level organizational dynamic capabilities can be achieved through a microfoundational account of the roles of individual actors [6,31,59] who shape the organization and higher-level phenomena such as dynamic capabilities [6,31,36,60].

Data-driven service innovation (DDSI) provides a rich context in which to explore the nature of service innovation [9,10] and the development of organizational capabilities. To illuminate value co-creation activities and their importance for DDSI, this paper takes a microfoundational view [6,31] and investigates the roles of individual actors and connected individual capabilities in that context. For this purpose, a Delphi study is carried out to investigate the roles together with practitioners. The Delphi study aims to reach consensus among a panel of experts in the field of DDSI to identify and evaluate

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individual activities, roles and the ordinary and dynamic capabilities they support.

2. Theoretical background – Individual actors and organizational capabilities during service innovation

During service innovation, activities, resources (e.g., physical, skills, information, knowledge) and practices are co-created or recombined through collaboration to develop solutions for new or existing problems and to deliver additional value [11-16]. Service innovation is inherently multidimensional and requires the involvement of a diverse range of actors from different organizations, units and functions. The required integration of resources cannot be carried out by a single actor and is likely to involve both external actors (e.g., customers, users, suppliers, external service providers, competitors, universities) and internal actors (e.g., top management, sales and service personnel, local subsidiaries) [17-19].

Identifying the requisite capabilities and managing multiple actors and their interaction can be complex [20], and different relationships must be established to facilitate each evolving role [21]. These roles are assigned during resource integration for value co-creation and are established through mental models, activities (such as resource exchange) and interactions with other actors [22]. Value co-creation depends on the interaction of these different actors and their joint or independent activities in enabling the exchange and integration of resources [23-26].

Especially individual actors are discussed as important during service innovation, due to the connection between individual activities and organizational outcomes [64,66]. Here, actors can have a radical or incremental influence on others and take expected or emerging roles, meaning that their roles lie in line with other actors' expectations or not [65,69]. In service innovation, individual actors may take on roles that depart from their formal (and static) position within the organization [3,23,27]. During such co-creation activities, actors may play different roles, sometimes simultaneously. The roles may change within the context of the network or in relation to other actors (that are not necessarily visible to others throughout the network). Understanding the relevance and relative importance of these roles is central to comprehending value co-creation processes among different actors [27,28].

To foster innovation capabilities, organizations must develop skills and knowledge of individual actors (e.g., thinking in systems, integrating and combining, inventive thinking, networking) [29]. Because individual actors contribute to innovative and co-creative interaction by applying their mental models [22], organizational capabilities ultimately depend on an understanding of individual capabilities [30]. This microfoundational view illuminates higher-level phenomena such as dynamic capabilities. This view locates "the proximate causes of a phenomenon (or explanations of an outcome) at a level of analysis lower than that of the phenomenon itself" [6, p.587] and suggests that the explanation of high-level phenomena should consider lower-level ones or actors [6,31]. In a nutshell, capabilities evolve on the basis of skills, knowledge (both as used by [67]), personal characteristics, experiences, and cognitions of individual actors that – in sum – form the whole organization [31]. During value co-creation by multiple actors, understanding individual roles and connected activities (e.g., gathering knowledge and information) on a micro-level facilitates the integration of organizational assets and the development and creation of organizational capabilities [32].

In today's fast changing business environment, where the sole possession of resources alone does not guarantee sustainable competitive advantage [33], organizations must develop dynamic capabilities if they are to fully exploit their resource base [34,35]. Dynamic capabilities relate to doing the right things and are usually strategic. In contrast, so-called ordinary capabilities are related to operation, governance and administration of organizational activities, thus indicating if activities are carried out right [36].

During service innovation, the development of dynamic capabilities is strongly influenced by the paradigm of value co-creation [37,38]. First, new modes of interaction emerge during sensing activities. Second, opportunities are seized, shifting the focus to customer value, based on continuous co-creation activities within the service system [37,39,40]. Finally, the service system must be orchestrated using organizational reconfiguration capabilities [37,38] and sustained by establishing a service-oriented mindset within the organization [37,41].

The multidimensional nature of DDSI results in a complex process that requires the development of organizational capabilities, based on skills and knowledge of individual actors in multiple roles. To identify the requisite organizational capabilities through the examination of individual actors, their capabilities, activities and roles during the innovation of data-driven services, this paper addresses the following research question: *What roles of individual actors are relevant and support the development of dynamic organizational capabilities during DDSI?*

3. Method

To answer the research question, we used a modified Delphi technique. Implementing the Delphi method elicits qualitative information from experts to identify relevant issues and their relative importance [42]. In a series of surveys, the technique seeks to establish a consensus within a group of experts from a given domain [43-45]. The group Delphi method allows for an interaction of participants in plenary sessions [46]. This group method preserves all other elements such as iterative feedback rounds, group judgements, and the possibility to revise opinions of a traditional Delphi study beside of anonymity [46]. The collaborative setting increases the participants' sense of responsibility and seriousness, producing results that gain higher acceptance within the group [47]. However, these plenary sessions need to be properly moderated to prevent the undue influence of dominant personalities. To that end, the moderator must seek to balance the inputs of more and less communicative panelists [46].

To identify individual actor roles contributing to DDSI, we invited 22 professionals with experience in that context (see Table 1).

Table 1. Overview of panelists

#	Position	Industry
1	Deputy General Manager	Manufacturing
2	Digital Transformation Program Manager	Finance
3	Director	Technology
4	Lead Product Manager	IT
5	Technology Director	IT
6	Partner Development Manager	IT
7	Business Transformation Head	IT
8	General Manager	Telecommunication
9	General Manager	Engineering
10	Director Digital Transformation	Technology
11	Chief Product Owner	Manufacturing
12	Head of Sales	IT
13	Program Manager	Engineering
14	Lead Portfolio Manager	IT
15	Senior Expert ICT	Telecommunication
16	Senior Director	IT
17	Senior Director	IT
18	CEO	Logistics
19	Lead Project Manager	Engineering
20	Process Architect	Engineering
21	Partner Manager	IT
22	Regional Business Development Manager	Telecommunication

To ensure sufficient knowledge about the phenomenon under investigation, the main selection criteria included a leadership position within their organization. All of these experts have deep knowledge of the DDSI process within their affiliated organization. To avoid cultural bias and to ensure a range of perspectives on the phenomenon in question, the selected international panelists were from different industries and varied backgrounds [46,48].

The modified Delphi method was used to rank issues to develop a consensus [42] through group interaction among the selected experts [46]. The first round explored the activities performed during DDSI. In the second round, the experts were asked to prioritize key activities, which were then ranked in a final third round (see Figure 1).

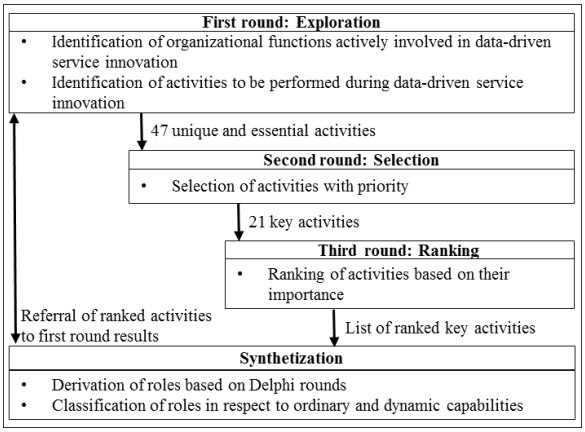

Figure 1. Implemented Delphi method [42,46]

To capture the activities performed during DDSI, an abductive approach was used to derive categories from the ground up as they emerged from the data analysis [49]. First, the activities mentioned by the panelists were coded descriptively, summarized in a short sentence or descriptive word. In a first overview of emerging topics, these descriptive codes formed the basis for further coding, analysis and interpretation [50,51]. In a second cycle, pattern coding was used to reduce the number of descriptive codes. Pattern codes are "explanatory or inferential codes, ones that identify an emergent theme, configuration, or explanation" [52, p. 86], synthesizing major themes into smaller sets of commonalities [50,52].

4. Findings

4.1. First Delphi round – Exploration of functions and activities

During the first round of the Delphi study, the panelists were asked about their understanding of what a data-driven service is. They were questioned to identify the actors that are actively involved in DDSI and the activities they perform. The initial questionnaire presented a range of organizational functions and external actors, as well as an open-ended option to identify other activities and free text fields for expressing further personal views without restriction. The initial results (summarized in Table 2) show that a majority of participants identified innovation management, R&D, customers, general management and the internal IT department as playing an active role during DDSI. As 86 % (19/22) of the panelists assumed that most activities could be handled internally, external actors such as universities and research partners received relatively few mentions.

Table 2. Organizational functions and external actors in DDSI

Rank	Function	Total / %
1	Innovation management	16 / 73%
2	R&D department	14 / 64%
3	Customers	13 / 59%
4	Management	12 / 55%
5	Internal IT department	11 / 50%
6	Marketing department	9 / 41%
7	Product management	9 / 41%
8	Service department	9 / 41%
9	Engineering department	6 / 27%
10	Purchasing department	5 / 23%
11	Sales department	5 / 23%
12	Universities & research partners	5 / 23%
13	External data service providers	3 / 14 %
14	Legal department	3 / 14 %

Additionally, the panelists referred to 47 essential and unique activities that need to be performed during DDSI. These activities were coded (as described earlier) and assigned to the following four categories.

(1) *Managerial*. The first category of activities includes decisions about market launches, risk and impact analyses, different areas of management across the organization, research on customer needs, and ecosystem analysis.

(2) *Processes & Methods*. This category includes enablement of internal interactions, planning for innovation, formulation of business rules, and design thinking, piloting, and prototyping.

(3) *Culture & Mindset*. This category includes promotion of lean thinking, ensuring team members' freedom, promoting continuous innovation, and promoting mindset change. Although linked to the first category, these activities are strategic in nature, differentiating them from managerial concerns.

(4) *Technical*. This category includes application of artificial intelligence (AI), machine learning, and data analytics or blockchain, as well as provision of knowledge in relation to technology, data architectures, chatbots, and domain-specific applications.

4.2. Second Delphi round – Identification of key activities

In the second Delphi round, the participants were asked to identify a reduced set of essential activities for DDSI. At the beginning of this round, examples of data-driven services were presented to the participants to gain a common understanding in the group and to enable the participants to revise previous statements on their understanding. Afterwards, the first round results were presented to the panelists and were brought up for discussion as well. The panelists extended the existing set of activities (see Figure 2) to include the following:

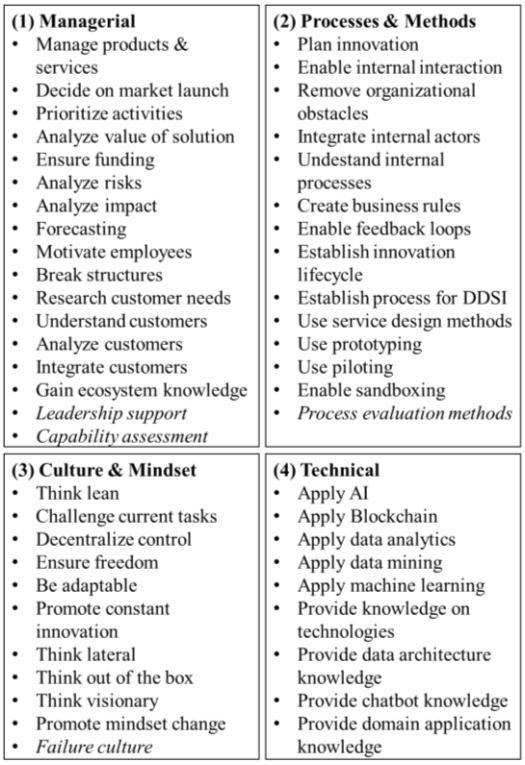

Figure 2. Categories and activities

leadership support and capability assessment (both to be added to the managerial category), process evaluation methods (processes and methods category),

and failure culture (culture and mindset category). This process yielded a total of 51 unique activities.

Participants were then asked to select five priority activities from each of the four categories. This yielded a total of 21 activities, three of which tied for fourth place in the Culture & Mindset category and were therefore progressed to the next round. After discussing the results, the panel made no changes to the 21 selected activities.

4.3. Third Delphi round – Ranking of activities by importance

Finally, the remaining panelists were asked to rank these 21 activities in order of importance. Table 3 reports these rankings, including average rank and inclusion in the top ten.

Table 3. Overview of activities and final rankings

Rank	Activity	Cat.	Avg. Rank	Ranked in top 10 by
1	Leadership support	(1)	4.2	82.0%
2	Understand customers	(1)	4.7	90.9%
3	Remove organizational obstacles	(2)	6.4	82.0%
4	Provide insights on customers	(1)	7.3	63.6%
5	Failure culture	(3)	7.4	81.8%
6	Support prototyping	(2)	8.2	72.7%
7	Establish process for DDSI	(2)	8.9	72.7%
8	Think visionary	(3)	9.0	63.6%
9	Enable feedback loops	(2)	9.7	72.7%
10	Decentralize control	(3)	10.1	63.6%
11	Promote mindset change	(3)	10.5	45.5%
12	Analyze value of solution	(1)	10.9	54.5%
13	Ensure freedom/Think out of the box	(3)	11.1	45.5%
14	Decide on market launch strategy	(1)	12.4	36.4%
15	Promote constant innovation	(3)	13.5	36.4%
16	Establish innovation lifecycle	(2)	14.7	27.3%
17	Machine learning	(4)	15.3	0.0%
18	Data analytics	(4)	15.7	0.0%
19	Domain-specific application	(4)	16.2	9.1%
20	Data architecture	(4)	17.1	0.0%
21	AI	(4)	17.7	0.0%

In this third round, only 11 of the 20 second round panelists responded. This low response rate and the panelists' reluctance to change their opinions indicated that further rounds would not be meaningful.

The third round results show that the panelists prioritized managerial activities such as leadership support and understanding customers. These are followed by activities such as removing organizational obstacles, providing insights on customers, and creating a failure culture, as well as processual and methodological activities like the support of prototyping and establishing a process for DDSI. Although many technical activities were mentioned as important and discussed during the initial rounds, these occupied the five lowest positions here. Top ten activities were ranked as such by at least 64% of the panelists, and technical activities were almost completely absent. Among technical activities, only domain-specific application gained a mention in the top ten (ranked 6th by a single panelist) while the rest completely failed to reach high rankings.

The strength of the group consensus was assessed by the calculation of Kendall's coefficient of concordance (W) [42]. Kendall's W is a non-parametric indicator; a value of 0 can be interpreted as complete absence of consensus within a group while a value of 1 indicates perfect consensus [43]. In the present case, a value of 0.41 for Kendall's W indicated weak to moderate group consensus on all activities. However, the top five activities achieved strong consensus, with a value of 0.73.

4.4. Synthetization of results

By synthetizing these results, it was possible to characterize actors' roles in DDSI. In particular, the prioritized activities from the third round were referred back to the activities and descriptive codes initially mentioned during the first Delphi round. This means that the roles were derived based on the statements from the panelists from all three Delphi rounds. For example, the description of the customer expert role does not only base on the derived code "Understand customers", but also on these exemplary statements of the panelists from the first round such as the necessity of *"a constant interaction with customers for reactive feedback for iterations"* or a *"good understanding of customers' problems and at what point in the journey"* that were coded to the activities from figure 2.

This yielded nine distinct roles describing the activities of individual actors.

(1) The customer expert provides deep knowledge of the customer and his needs throughout the DDSI process, based on research activities and direct and continuous interaction with the customer.

(2) The supporting manager ensures top management support for establishing a failure culture and the freedom of other actors to unleash their creativity and think "out of the box."

(3) The innovation enabler establishes processes that balance product and service innovation and promotes the constant pursuit of innovation to ensure adaptability throughout an appropriate lifecycle.

(4) The bridge builder contributes a deep understanding of the organizational environment and removes any obstacles that might prevent collaboration at intra- and inter-organizational level.

(5) The prototyper establishes and implements prototyping methods to assess the feasibility of the innovated solution(s), enabling iterative feedback loops and setting suitable timeframes for prototyping.

(6) The strategic operationalizer puts the innovation into action, decides how solutions are advanced to the next process step and devises market launch strategy.

(7) The mindset visionary identifies current market trends for vision delivery and promotes mindset change to facilitate innovation of data-driven services.

(8) The technical expert provides the required technical knowledge on artificial intelligence, machine learning and other technologies across the entire process of DDSI and assesses the technical feasibility of the new solution(s).

(9) The t-shaped expert links the insights delivered by the technical expert to domain-specific applications to ensure correct data interpretation for appropriate solutions that offer additional value to the customer.

As a next step, these roles were classified as supporting the development of ordinary or dynamic capabilities. In the latter case, actor roles related to sensing, seizing and transforming capabilities for service innovation (see Figure 3). The *technical* and *t-shaped expert* roles support ordinary capabilities. The technical expert provides knowledge on IT-related technologies, and the t-shaped expert connects these to domain-specific knowledge. Both roles are highly operational and can be outsourced to external service providers rather than residing within the organization.

Roles that support the development of dynamic capabilities can be characterized as follows. The *customer expert* senses new opportunities in the market through direct interaction with the customer and research on their needs. In seizing identified opportunities, the *bridge builder*, *prototyper*, and strategic *operationalizer* support dynamic capability development by dismantling organizational barriers to facilitate reconfiguration of existing resources, parallel prototyping of multiple solutions, and timely market introduction. The *supporting manager* and the *innovation enabler* can be assigned to a dual role of seizing and reconfiguring. They provide the freedom and structures to seize opportunities and reconfigure the organization by implementing a new culture of ongoing innovation that encourages employees to try new things. Finally, the *mindset visionary* is mainly responsible for reconfiguring the organization by defining a vision for the whole organization, shaping the future mindset and supporting the realignment of organizational assets to ensure sustainable competitive advantage.

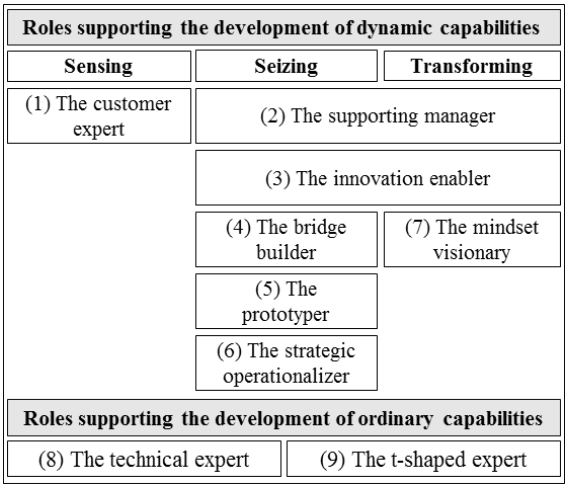

Figure 3. Roles supporting ordinary and dynamic capabilities

5. Discussion

This study sheds light on individual actors, roles, and activities involved in DDSI in relation to traditional functions. The findings indicate a strong focus on managerial activities rather than technical knowledge. Synthetization revealed nine actor roles and associated ordinary and dynamic organizational capabilities.

The study at hand extends existing research on actor roles during co-creative DDSI [23,24,26] by identifying roles of actors at a micro-level and connecting these to the higher-level phenomenon of dynamic capabilities [31,32]. The present findings consolidate earlier evidence that actors from internal departments such as innovation management, R&D, management and IT, as well as customers, play a vital role in successful innovation of data-driven services [17,18]. The findings emphasize roles that do not align completely with organizational functions or their assumed importance. For instance, the roles deemed most important relate to facilitating leadership support for a culture that allows for failure and fully exploits knowledge of customer needs and their understanding. Formal organizational functions such as management and sales were considered less important than the activities they perform in the context of DDSI – in other words, co-creative actors' roles in DDSI are characterized by the specific activities they perform

rather than by their formal organizational designation [23].

This emphasis on roles rather than formal organizational functions reflects how dynamic environments require actors to change their role to facilitate fruitful co-creation activities such as DDSI [27,53]. The roles described here are not executed by single actors alone, and individual actors can perform multiple roles as their environment changes [23]. For example, the roles of supporting manager and mindset visionary can (but need not) be performed by one actor.

The relevance of actor roles that support sensing, seizing and reconfiguration capabilities serves to clarify how organizations can achieve sustainable competitive advantage through dynamic capability development [54]. In particular, the importance of strategic and managerial activities that shape the organizational mindset and culture shows that successful DDSI relies heavily on the development of dynamic capabilities. This is supported by the perceived lesser importance of technical activities such as application of AI, data analytics, machine learning, or domain-specific knowledge. As ordinary capabilities that are imitable and cannot ensure sustainable competitive advantage, these operational functions can readily be outsourced to external service providers [36].

The lesser importance of technology in exploiting new service opportunities serves as a reminder that DDSI presents partially the same challenges as service innovation in general. However, they are gaining in complexity through the utilization of data. As long as organizations do not promote a service-oriented mindset through top management [55,56] and establish suitable internal processes for service innovation [57,58], an engagement with mainly DDSI related challenges can be impeded. In such cases, the deeper focus on technological issues becomes more difficult, as does the development of appropriate dynamic capabilities that are relatively inimitable [36].

Roles such as the technical or t-shaped expert could be furthermore regarded as ordinary due to their incremental and expected nature. Both of them just provide knowledge on an operational level. In contrast, roles that support dynamic capability development show characteristics of being more emerging and radical [65,67]. This can be exemplified by the mindset visionary that has the ability to act radical and emerging due to his role to deliver visions, by the customer expert that can act unexpectedly on novel demands from customers or the strategic operationalizer that creates his role throughout DDSI which has not to be in line with the expectations of others. An explanation for the underrepresentation of roles that support sensing activities could be that the customer acts as an active innovator during DDSI, thus lowering the demand for further sensing capabilities beside of the customer expert. Finally, the study's findings confirm the importance of integrating actors and micro-level activities in order to develop higher-level dynamic capabilities [6,31] for innovation of data-driven services. Concrete description of individual roles and activities to support the development of such capabilities [6,31,32] helps to achieve sustainable competitive advantage by doing the right things rather than just doing things right [36]. The identified roles can help to support organizational outcomes through individual activities [6] and their contribution towards DDSI [64]

6. Conclusion and outlook

In summary, this study identifies the roles of individual actors in DDSI and the capabilities required, specifying their relative importance as perceived by a panel of selected experts. The paper identifies nine roles and links these to the dynamic capabilities framework to show how micro-level activities help to build higher-level dynamic organizational capabilities within organizations. This study shows that actor roles during DDSI can support both ordinary and dynamic capability development. While roles incorporating technical knowledge and their domain specific application have the potential to be outsourced to external service providers due to their lower perceived importance, strategic and managerial roles that shape an organizations mindset support the development of dynamic capabilities. The paper emphasizes that multiple roles can be taken by single actors and that the identified roles go beyond static and formal organizational roles that were perceived less important than the activities they perform.

From a managerial perspective, the findings help organizations to define the roles and activities of those involved in DDSI. By developing these dynamic capabilities, managers can build competitive advantage through data-driven services. This implies that teams for DDSI should be constructed on the basis of these roles and activities rather than adhering to formal and often static organizational roles.

Beyond these timely contributions, this Delphi study has certain limitations that need to be considered. In particular, the composition of the expert panel limits the representativeness of the findings. Although diverse in terms of industry and background, the participants provide only an internal perspective on data-driven service providers and not the customer perspective. Furthermore, the expert panel com-

position does not only limit the representativeness of the findings, but also effects the findings of the study. A more heterogeneous composition might have led to other roles. Different cultural context and diverse educational background might have resulted in different activities and roles for DDSI.

The study opens up some interesting avenues for future research in the developing field of DDSI. First, the identified actor roles and capabilities should be investigated and refined, using a combination of qualitative and quantitative methods to validate our findings. Additional insights from in-depth exploration of the capabilities that organizations have built would help to advance our understanding of how dynamic capabilities build competitive advantage in rapidly changing environments.

Beyond the insider view, future research could explore the whole ecosystem around providers of data-driven services. This may reveal additional roles of relevance to DDSI, encompassing external actors such as customers, suppliers, and research partners or others and assess if they are needed to innovate data-driven services. Furthermore, future research could investigate specific data utilization triggered aspects rather than taking a broad view on the phenomenon of DDSI as in the present study.

Finally, future studies may investigate the surprising finding that technical aspects are assigned relatively low priority. It would be interesting, for example, to determine whether this rests on an assumption that technical issues can be more easily mastered during data-driven services innovation or whether it reflects deficiencies in dynamic capabilities for organizational transformation.

7. Acknowledgements

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