Value Propositions in the Internet of Things: A Taxonomy of B2B Smart Services

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***Abstract*— Connected and smart products are giving rise to smart services that leverage their advanced capabilities and promise profitable business models. However, many companies in the Internet of Things domain are still struggling to integrate smart services into their portfolios, and more research is needed to facilitate service innovation and adoption. We, therefore, identify common characteristics of the value propositions of B2B smart services and summarize them in a taxonomy. The taxonomy development follows established methods and is based on a systematic literature review of 31 scientific articles and the study of 100 empirical objects. To confirm the validity of our findings, we conduct two ex-post evaluations. Our research provides descriptive knowledge about B2B smart services that can serve as a foundation for further research on smart service innovation.**

Keywords— Smart services, B2B, Internet-of-Things, Smart service innovation, Taxonomy

I. INTRODUCTION

Kimberley-Clark, a global provider of products for public restrooms, is equipping its soap dispensers with sensors to measure consumable levels. When levels become critically low, cleaning crews are notified. This digital service enables cleaning and replenishment based on actual consumption rather than fixed time slots, ultimately saving time and money while ensuring customer satisfaction. Adding connectivity, sensors, processors, and actuators to products such as soap dispensers offers opportunities for new product features, increased efficiency, utility, and better margins [1], [2]. This trend toward *smart* products allows firms to transcend traditional product boundaries and create new service business models with existing and new customers [3]. Transforma Insights [4] predicts that the number of smart products connected to the Internet will reach 29.4 billion by 2030. Smart products give rise to smart services that leverage the products' advanced capabilities to provide customers with enhanced insights, optimizations, remote acting, and autonomy [1], [5].

Despite these opportunities, many companies in the B2B domain are still struggling to add smart services to their portfolio [6]–[8], posing a potential threat to their future market share [3], [9]. This struggle often stems from an unclear smart service strategy, inadequate value propositions, and a lack of systematic service innovation processes [7], [10]. Given the unique complexities of B2B smart services, which often involve multiple actors and complicated business models, these barriers require an in-depth understanding [11], [12]. Although previous studies have attempted to identify these barriers and propose strategies to overcome them, their efforts are often hampered by the lack of an analytical foundation that accurately describes the multi-faceted nature of B2B smart services. This foundation could take the form of a classification scheme, framework, or taxonomy [13].

While taxonomies exist for smart services [14], smart service systems [15], and data-driven services in the manufacturing industry [16], they do not fully capture the unique characteristics and complexities of B2B smart services. For example, these taxonomies often consider only static pricing models and low-interaction services [14], [15], and include non-functional value propositions that play a minor role in B2B relationships [17]. To effectively facilitate further research and innovation in the area of B2B smart services, a more applicable taxonomy is needed. Such a taxonomy would not only allow for the categorization of B2B smart services based on their similarities and differences, but would also serve as a tool for practitioners to understand, compare, and communicate their service offerings. This is where other forms of descriptive knowledge may fall short, as they may not provide the same level of clarity and structure needed to address the diverse range of B2B smart services [18].

Therefore, our objective is to provide an analytical tool that accurately reflects the diversity and complexity of B2B smart services by addressing the research question: *"What dimensions and characteristics can be used to analyze the similarities and differences between B2B smart services?"* To answer this question, we develop a taxonomy of B2B smart services following established methodological guidelines [18], [19]. Our research process includes a systematic literature review of 31 articles and an analysis of publicly available descriptions of 100 B2B smart services in six iterations. We enhance the validity of our findings by conducting two ex-post evaluation episodes with experienced researchers. The resulting taxonomy comprises seven dimensions with associated characteristics that define the constitutive properties of B2B smart services.

These findings contribute to the descriptive knowledge of B2B smart services and provide a solid foundation for future research on smart service innovation. We identify common characteristics of such services and group them in a compact framework, providing a systemization of the topic on which future research can build. For practitioners, our results offer insights for understanding, comparing, and communicating their service offerings, and can serve as a starting point for developing new services.

The article is structured as follows: we first provide an overview of the related literature, then outline the research method for developing the taxonomy. Section IV presents the final taxonomy in detail. Finally, we discuss the implications and limitations of our findings.

II. Foundations and Related Work

A. IoT-based Smart Services

Equipping physical objects with unique identification and communication technology improves object visibility and gave rise to the Internet-of-Things (IoT) [20]. It was initially defined as a technical architecture to track and identify objects, thereby integrating them into information systems [21]. Today, most scholars have a wider view of IoT as an architecture of objects with ubiquitous communication technologies, sensors, actuators, and processors connected to the Internet and each other [2], [21]. These connected objects are called smart products [1], [5], and their degree of smartness can be assessed on multiple levels. Porter and Heppelmann [1] examine the smart components of a product, including sensors, data storage, controls, software, and operating systems. Valencia et al. [22] define dimensions of smartness enabled by the smart components, such as autonomy, adaptability, reactivity, and cooperation with other devices. However, not all smart products necessarily comprise every smart component and dimension [5].

The smart soap dispenser described earlier has sensors and connectivity to detect decreasing soap levels but lacks actuators and autonomy. In contrast, the smart electric vehicle charger by Clever [23] uses built-in actuators to charge a car autonomously when the most renewable energy is available. In both cases, the smart product enables the provision of a new type of service called "smart service," which is "characterized by a high degree of autonomous data capture, event transfer, network connectivity, and interoperability" [20, p. 2789]. The smart product acts as a boundary object between the smart service user and provider by mediating their interactions [5]. It lies between the service consumer and provider, who do not interact directly but rather indirectly through the smart product. The smart product forwards the data or information to the other actor, separating them through individual lines of visibility that determine what activities and resources the other actor can see and access, thereby determining how they indirectly interact [5]. In the case of the soap dispenser, cleaning personnel performs a self-service, while in the Clever case, the provider connects remotely to control the energy flow.

Smart service performed in smart service systems is characterized by the co-creation of mutual value [24], [25]. In such smart service systems, smart products play a more active role than in traditional service systems, as they are the central element of the value-creation process [5]. For instance, a customer of a smart machine can use a monitoring service to create value-in-use by collecting production data, identifying inefficiencies, and taking action [5]. Meanwhile, the service provider gets paid for this service and can further process the data to optimize the product's performance or customize the offering to the user's needs, increasing value for both parties [1], [3]. Additionally, smart services can create more value by enabling smart products to act autonomously or be remotely controlled [5].

Smart services exist in both B2B and B2C environments, sharing some common characteristics and typical business model elements while differing in others [26]. Compared to B2C, B2B smart services generally have higher requirements for reliability, cybersecurity, and intellectual property protection [27]. As a result, they rely on trusted, long-term business relationships, which ensures a steady demand and revenue for providers but makes it more challenging to introduce disruptive changes and acquire new customers [28]. Consequently, B2B service providers tend to focus on extending their core business model through product-centric smart service innovation [28], [29]. Customer involvement in this process is less common for B2B smart services, which may lead to incremental rather than disruptive innovation, according to related studies ([29], [30]). In addition, B2B smart services are more likely to rely on machine-to-machine interaction, which reduces the operator's workload by performing an action automatically [11]. Such services are, e.g., preemptive services that prevent product failures, improving product quality and productivity while reducing the customer's labor and energy costs [3], [31].

The business models of B2B smart services are characterized by a high degree of individualization and the involvement of multiple actors in both development and operation [12], [28]. The key activities of these business models vary in complexity. Some companies start by offering simple smart services, such as providing product-related data with minimal processing. In contrast, others offer more advanced smart services that integrate multiple data sources and require complex data processing (e.g., sensor fusion) to create greater value [32]–[34]. Additionally, smart service business models include digital platforms that bundle smart service offerings and potentially include third-party services from external providers [32], [35], [36].

B. Taxonomies for Smart Services

Gregor [13] proposes a typology of theories for advancing information systems (IS) research and suggests that "theories for analyzing" form the basis for other types of theories that provide explanations, predictions, or prescriptions. Theories for analyzing "say what is" by studying a particular subject and providing some form of classification, which can refer to both the organization of knowledge and the organization of instances of the subject [37], [38]. We adopt Doty and Glick's [39] definition, which states that taxonomies are constructs that classify the subject along multiple dimensions based on decision rules. Taxonomies can be created empirically, based on observations and exemplary objects [40], or conceptually, based on existing theories [19]. In the process of taxonomy development, common characteristics of the subject are identified and summarized [13].

On the topic of smart services, there are already existing taxonomies (e.g., [14]–[16]), which, however, do not sufficiently cover the dimensions and characteristics of B2B smart services. Paukstadt et al. [14] proposed a taxonomy of smart services that categorizes the service concept, delivery, and monetization. However, they do not focus on the B2B context. So, for example, the *value proposition* dimension, which distinguishes between hedonic, functional, and social value, helps differentiate B2C smart services but is less applicable in a B2B setting, where functional value dominates [17]. Azkan et al. [16] provide a manufacturing industry-specific smart service taxonomy that complements the findings of Paukstadt et al. [14] by providing context-specific insights in different dimensions, such as main value, data sources, and aggregation level. Their taxonomy provides more detailed insights relevant to B2B smart services, but it may be too narrow for some cases beyond manufacturing.

Brogt and Strobel's [15] taxonomy provides insights into how value is co-created in smart service systems. The authors replace Paukstadt et al.'s [14] *social* value propositions with *financial* value propositions, while all four types of value propositions originate from a study by Rintamäki et al. [41]. However, applying this dimension to cases of B2B smart services suggests that these characteristics overlap strongly, as efficiency gains and increased transparency—common examples of the functional value of B2B smart services [1], [3]—directly manifest themselves in the form of financial value through reduced labor, material, and maintenance costs. The taxonomy also considers the level of automation in smart service systems as *semi-automated* or *automated*. The authors argue that smart products already have some degree of automation, so the smart service system is at least semi-autonomous. However, many B2B smart services, such as monitoring services for machines, require much human interaction and have very limited autonomy [42], [43].

III. RESEARCH METHOD

This section outlines the research process and techniques used to build the taxonomy. Nickerson et al.'s [19] method for developing taxonomies is used in about two-thirds of the taxonomy articles in the IS domain [18]. It implements a rigorous design process based on the design science research paradigm. Kundisch et al. [18] proposed an Extended Taxonomy Design Process (ETDP), which builds on Nickerson et al.' [19] method and provides researchers with more concrete methodological guidance for the design and evaluation phases, promoting consistent method application and transparent reporting. Adopting the ETDP for this research strengthens the rigor of the taxonomy development and enables readers to better understand the design and evaluation approaches chosen.

The ETDP consists of six steps, with certain steps allowing for multiple iterations. Fig. 1 shows the process and iterations performed during the taxonomy development. We briefly introduce each of these steps and explain them in more detail below, with a particular focus on the design and development of the taxonomy (III.A) and its evaluation (III.B), before communicating the resulting final taxonomy in Section IV.

In the *problem identification and motivation* step, we introduce our subject of research, B2B smart services, and explain why a taxonomy of these services is useful for our primary target audience of scholars who aim to explain or predict phenomena related to such services (e.g., "What are the success factors of profitable B2B smart services?", "How should organizations adapt to become a smart service provider?" [44]). The goal of developing the taxonomy is to propose a simplified description of B2B smart services by revealing their constituent characteristics and organizing them into dimensions. Our preliminary study found that B2B smart services significantly differ from other smart services in a B2C environment. This highlights the relevance of developing a taxonomy that emphasizes B2B-specifics for future research on this concept (cf. Section II.B).

In the next step, the *definition of solution objectives*, we determine which information characteristics must be included to answer the described questions of our target group. Our meta-characteristic reads: "Key characteristics of B2B smart services that describe how the service is perceived and delivered". This statement guides us in assessing the usefulness of potential characteristics in the subsequent steps. Additionally, we define the ending conditions of the taxonomy development process and the evaluation criteria. All eight objective ending conditions (E1-E8, see Fig. 2) and subjective ending conditions (*conciseness*, *robustness*, *comprehensiveness*, *extendible explanatory*) suggested by Nickerson et al. [19] are adopted. Further, we select ex-post evaluation criteria (*completeness*, *simplicity*, *understandability*, *fidelity with the real world*) based on our target audience and taxonomy goals.

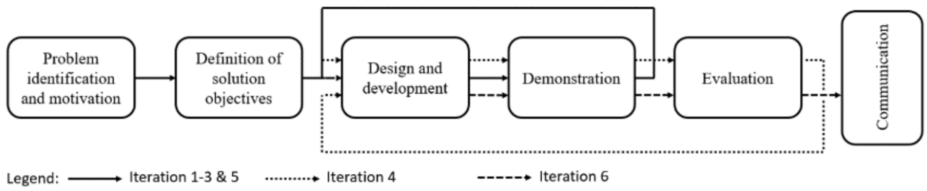

Fig. 1. Extended taxonomy design process based on Kundisch et al. [17]

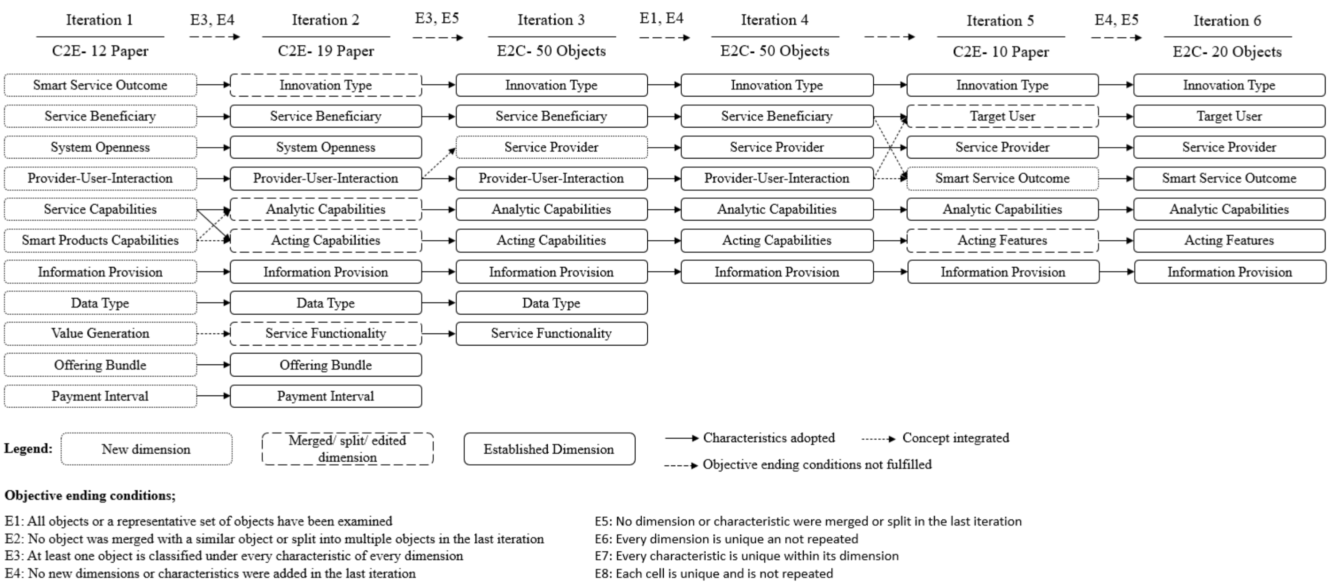

Fig. 2. Overview of iterative taxonomy design and development

A. Iterations of Taxonomy Design and Development

Next, we *design and develop* the taxonomy by iterating between two design approaches: The first approach, conceptual-to-empirical (C2E), uses existing knowledge about the subject [19], including literature reviews or researchers' experience and judgment [18]. The second approach, empirical-to-conceptual (E2C), involves examining real objects of the studied topic to identify common characteristics and form a conceptual understanding. In total, we conducted six *design and development* iterations, which are described in more detail below. Before the first iteration, a preliminary search indicated that the literature provided relevant information on the topic and that several real objects were available, allowing us to apply both design approaches [19]. However, we chose the conceptual-to-empirical approach for the first iteration because the empirical objects were very diverse, so we wanted to start with the more structured literature and focus on more mature concepts.

Iteration 1: First, we followed the conceptual-to-empirical approach starting with a comprehensive systematic literature review following the methodological guidelines of vom Brocke et al. [45] to obtain a broad overview of the existing knowledge base [46]. To build our search string, we identified three relevant subtopics (TABLE I): Topic A includes the primary subject of "service," while Topic B includes synonyms for "smart." Finally, Topic C captures research outcomes and methodologies that might reveal characteristics of the subject. We created the search string by linking topics A, B, and C with an AND operator.

TABLE I. Systematic literature review search term

Topic	Search terms
A	service*
B	IoT OR "Internet of Thing*" OR "smart servi*" OR smart OR cyberniz* OR "internet-of-thing*" OR IIoT
C	characteristic* OR classification; conceptualiz* OR taxonomy; archetype*; typology OR "maturity model*" OR morphology OR cluster* OR survey*; taxonomies OR morphologies OR typologies OR morphological

Following the approach suggested by Webster and Watson [46], we searched for articles in IS journals and conference proceedings and journal articles in related fields (i.e., management, production, organization). To ensure the quality of the articles, we applied several criteria, such as the articles being peer-reviewed and established scientific rankings of journals and conference proceedings. The Scopus and Web of Science databases were used to identify 157 articles, which were then independently rated by two authors for relevance to the subject, reducing the literature sample to 24 articles. We also conducted forward and backward searches, which identified an additional seven articles, bringing the total to 31 articles.

For the analysis, we divided the literature sample into two groups. We examined 12 taxonomy-related articles in the first iteration, leaving the remaining 19 articles for iteration 2. Our goal for this first iteration was to collect a wide range of dimensions and characteristics that could be narrowed down in the later iterations. The resulting dimensions are shown in Fig. 2. We checked the objective ending conditions (Fig. 2) and determined that no objects had been examined yet, so no object was classified under any characteristic (E3). In addition, all dimensions were newly created (E4). Since not all objective ending conditions were met, we performed another iteration.

Iteration 2: Next, we used the remaining 19 articles to perform another conceptual-to-empirical step to strengthen the soundness of the existing dimensions and characteristics. We mapped the concepts to the existing dimensions and characteristics to do this. As a result, several changes were made, such as renaming the *smart service outcome* dimension to *innovation* and removing characteristics that were not directly related to innovation (e.g., business insights and efficiency gains). The *service capabilities* and *smart product capabilities* dimensions were merged and split based on the type of capability addressed (*analytic* or *acting*), while the *service functionality* dimension was developed by splitting the value-in-use and value-in-exchange characteristics (i.e., decision support, quality control, predictive operations). The evaluation of the objective ending conditions showed similar results as in the first iteration (E3, E5) since no real objects have been studied yet.

Iteration 3: In this iteration, we used the empirical-to-conceptual approach based on publicly available use case descriptions of smart services. To evaluate potential use cases, we define a set of five criteria: (1) written in English or German, (2) describes a B2B smart service with a smart product as the boundary object, (3) has a clearly defined value proposition for the customer and potential secondary beneficiaries, (4) provides a comprehensible description of how the service is delivered, (5) is implemented and tested in a real-world scenario, and (6) is scalable across customers with only minor manual adjustments. We collected 100 cases and used half of them for this iteration to delete dimensions that were not supported by enough use cases. For example, we found that *offering bundle* and *payment interval* did not represent a constituent factor of B2B smart services due to their inflexible nature and dynamic and complex value capture configurations in cases involving multiple actors. Therefore, we added the *service provider* dimension to the taxonomy to map the provider side of the provider-user interaction and to reveal the types of actors involved. However, because not all objects were yet considered and a dimension was added, two of the objective ending conditions were not met (E1, E4).

Iteration 4: We performed another empirical-to-conceptual step with the remaining 50 objects. During this process, we deleted the dimension *data type* because most smart services use a wide range of data types, making it challenging to identify a concise set of meaningful characteristics that match the use cases. Furthermore, we found that the dimension *service functionality* did not align well with the studied objects and overlapped with the *innovation type* and *analytics capability* dimensions, which led us to remove it from the taxonomy. After this iteration, all objective ending conditions were met, and we discussed the subjective ending conditions among the authors. We considered the taxonomy concise, as it included the most important characteristics identified in the four iterations. The number of dimensions (n=7) was within the size interval recommended by Nickerson et al. [19]. The *robustness* and *comprehensiveness* of the taxonomy were confirmed by re-evaluating the objects of this iteration. Since the dimensions and characteristics were generally independent, the taxonomy is also *extendible explanatory.* Thus, all ending conditions seemed to be met.

To evaluate the taxonomy, we conducted a focus group using the criteria defined at the beginning of the ETDP. In the focus group, we explained the taxonomy and presented two use cases for the participants to code using the taxonomy. Since our target users are researchers, we recruited six scientists with a background in smart service research. The participants' assessment was collected based on the evaluation criteria, and the participants could provide additional feedback in written or oral form. Overall, the evaluation showed an insufficient fulfillment of the criteria, with a hit ratio of only 60 % to 70 % for the respective dimensions. Therefore, we decided to re-iterate the preliminary findings and address the following overarching suggestions made by the focus group: (1) The target user and purpose of the taxonomy should be addressed more specifically in the taxonomy. (2) The dimensions *service beneficiary* and *provider-user interaction* neglect the widely accepted understanding of value co-creation in service systems [47]. (3) The labels and descriptions of the characteristics should be simplified and more concise.

Iteration 5: Afterward, we used the insights gained throughout the taxonomy-building process and the feedback from the focus group to supplement our data with additional literature specific to the dimensions being reconstructed (conceptual-to-empirical). Based on the feedback (2), we added the *target user* dimension, which combines concepts from the *service beneficiary* and *provider-user interaction* dimensions. We also reintroduced the *smart service outcome* dimension instead of describing the provider-user interaction. To better reflect the characteristics of the dimension, we renamed *acting capabilities* to *acting features*, and further split its characteristics for a more precise characterization. These changes and adding dimensions led to the non-fulfillment of the two objective ending conditions (E4, E5).

Iteration 6: We re-evaluated 20 use cases from iterations 3 and 4 by applying the current taxonomy (empirical-to-conceptual) in this iteration. We checked if the dimensions matched the cases and determined whether any characteristics or dimensions were missing. We did not change the taxonomy, so all objective ending conditions were met. We also reviewed the subjective ending conditions and concluded that the two additional iterations, guided by the focus group feedback, improved the level of fulfillment of the criteria assessed in iteration 4. Consequently, all subjective ending conditions were met, and we could proceed with another evaluation episode.

B. Evaluation of Final Taxonomy

After the sixth design and development iteration, we conducted an ex-post evaluation by presenting ten B2B smart service cases purposively sampled from our dataset to 13 researchers with medium to high experience in smart services. The participants were asked to use the taxonomy to code the case descriptions, allowing us to evaluate their inter-coder reliability. We provided the researchers with the smart service description published by the service provider, highlighting the most relevant paragraphs. We also shared a summary of the smart service, including its value proposition, the user and provider of the smart product, and the user and provider of the smart service. To reach an agreement on the "ground truth" coding, the authors independently coded the taxonomy and discussed any discrepancies that arose. We then used hit ratios to assess the inter-coder reliability [48] by calculating each participant's hit ratio for each characteristic and averaging the results to obtain dimension-specific hit ratios, as shown in TABLE II.

The survey group achieved an average dimension-specific hit ratio of 79 %, with the *innovation type* dimension having the lowest hit ratio (65 %). Four dimensions had a hit ratio of > 80 %, and two dimensions > 70 %. The *information provision* dimension had the highest hit ratio (88 %). These results indicated the validity of the taxonomy, with six dimensions having more than 70 % of correct placements and strong overall reliability [48], [49], supporting the credibility of the designed taxonomy and confirming its applicability. However, the evaluation also highlighted the *innovation type* dimension as a weak point of the taxonomy, with only about 2/3 of the participants choosing the "correct" characteristic for the selected cases. Thus, further research is required to confirm the validity of this dimension, which is commonly used in existing smart service taxonomies [14], [16].

TABLE II. Results of the second evaluation episode

Dimension	Hit Ratio
Innovation Type	65 %
Smart Service Outcome	85 %
Service Provider	82 %
Target User	85 %
Analytic Capabilities	70 %
Acting Features	77 %
Information Provision	88 %
Average	***79 %***

IV. A TAXONOMY OF B2B SMART SERVICES

This section presents the final taxonomy of B2B smart services (TABLE III) consisting of seven dimensions and corresponding characteristics. The last column of the table indicates whether each dimension is exclusive (E), with a single applicable characteristic, or non-exclusive (N), with the potential for multiple characteristics to apply. In parentheses, we indicate the number of occurrences of each characteristic in the sample of 100 use cases. For non-exclusive dimensions, the total number of occurrences may exceed the number of cases.

TABLE III. Taxonomy of B2B Smart Services

Dimension	Characteristics				E/N
Innovation Type	Incremental Improvements (58)	Added Functionality (34)	Radical New Offering (8)		E
Smart Service Outcome	Transparency (83)	Optimization (51)	Remote Control (13)	Autonomy (16)	N
Service Provider	Smart Product Manufacturer (54)	Retrofit Supplier (35)	Smart Product Operator (17)	External Partner (8)	N
Target User	Smart Product User (71)	Smart Product Provider (21)	External Actor (11)		N
Analytic Capabilities	Descriptive (25)	Diagnostic (38)	Predictive (15)	Prescriptive (12)	E
Acting Features	Physical (16)	Digital (7)	Process Triggering (10)	None (67)	N
Information Provision	Push (20)	Pull (75)	None (14)		N

A. Taxonomy Description

Innovation type. This first dimension in the taxonomy captures the novelty of the smart service's value proposition to the user. We compare the value proposition of an original service system that includes a non-smart product and related services, such as maintenance, repair, and operations, to the value proposition in the smart service system. If the original focal value proposition remains the same but is enhanced by cost reduction, time savings, or increased flexibility [44], we classify the services as *incremental improvements* [50], [51]. For example, Siemens uses data collected at a soldering line to predict the likelihood of a non-functioning solder joint, reducing the number of parts that need to be X-rayed and ultimately reducing lead times while maintaining customer satisfaction [52].

Smart services that provide additional functionalities and give rise to new value propositions are identified as *added functionality* [53]. These new functionalities extend the smart service system's core functionalities and value propositions [14]. For example, FedEx introduced online package tracking [54], which allows users to derive additional value beyond the delivery of a package as package tracking enables advanced planning for the customer. Finally, the *radical new offering* characteristic refers to smart services that change the primary value proposition perceived by the business user [14], [50], [55]. This type includes innovative services, such as augmented guidance through Google Glasses [56]. The primary value proposition of such glasses differs significantly from normal glasses with clear lenses that can be used to protect the eyes, as they afford customers in the logistics domain to augment the fastest routes into the field of vision of their employees, reducing picking times while keeping their hands free. The novel value propositions of these smart services dominate the perceived value of their users and ultimately determine their decision to participate in the smart service system [57]. Although we acknowledge that the line between *added functionality* and *radical new offering* may be somewhat continuous, we allow the selection of only one characteristic in this dimension to focus on the primary value proposition to the smart service user.

Smart service outcome. This dimension encompasses four characteristics: transparency, optimization, remote control, and autonomy [16]. By providing information about their environment, status, and usage to their users or external parties [1], [58], smart products can increase *transparency* and provide a better understanding of usage patterns, related processes, or the customers themselves [59]. This information can be further processed to derive actionable insights [58]. *Optimization* refers to smart services that inherently contain actionable insights to improve the product's value-in-use [59]. This includes data-driven recommendations for smart product configuration parameters or usage behavior adjustments [16], [58]. Other actors in the smart service system can also optimize their value, e.g., by improving their interaction with the product, related processes, customer contact, or product design [5].

Remote control of the smart product allows actors to send information and commands to the smart product remotely, increasing its value-in-use for onsite users [5], [58]. More advanced smart products are capable of making many adjustments *autonomously* without any human interaction [58], [60], reducing the workload of the actors and responding to changes in the environment in real-time [5]. Several characteristics may apply simultaneously (e.g., a provider optimizes its understanding of the usage behavior and remotely controls the smart product to adapt it to the user's needs). This makes the dimension non-exclusive.

Service provider. This dimension explores the different roles that the actor providing and marketing the smart service can play in the smart service system. We group the roles into four categories: smart product manufacturer, retrofit supplier, system operator, and external partner. First, the *smart product manufacturer* can provide additional smart services to complement its products and increase the overall value proposition [1], [29]. Second, a *retrofit supplier* can provide the technical infrastructure, such as sensors and communication technology, to make a product smart [29]. Third, the *system operator,* who is responsible for operating the smart product in the field [29], may provide, for example, services related to staffing, maintenance, or consumables. Finally, *External actors* are those that do not fit any of the other characteristics and may include, e.g., external application developers or physical service providers.

Companies can play several roles at once, such as a tool manufacturer that offers its customers a service to track the performance of its products (smart product manufacturer) while also allowing for third-party products to be integrated into the tracking system (retrofit supplier). In addition, large manufacturers may choose to increase the smartness of purchased products and create smart services for their own use, acting simultaneously as system operators and retrofit suppliers. Thus, this dimension is non-exclusive and allows for the selection of multiple characteristics.

Target user. Similar to the provider dimension, several actors in the overall service system can fill the role of the target user, i.e., the primary beneficiary who decides to participate in the smart service exchange. For example, *smart product users* enhance their product use through the smart service and derive improved or new value-in-use. In addition, *smart product providers* can use smart services to optimize their products or their interactions with them, for example, by using field data to improve simulation models of the product's behavior. Finally, *external actors* can benefit from smart services that leverage the smart product's capabilities. This may include, for example, gaining insight into the usage patterns of smart products and their environment or interacting directly with the smart product [58].

Analytic capabilities. Smart services rely on data analytics to derive valuable information from data [61]. We distinguish four types of analytics: descriptive, diagnostic, predictive, and prescriptive analytics [1], [62]. *Descriptive analytics* involves preparing, aggregating, and visualizing past or present data to identify what has happened or is happening [62]–[64]. Basic analytical models, such as thresholds or if-else rules, can be applied to extract and communicate more useful results to a human operator or a machine [61]. *Diagnostic analytics* go beyond descriptive capabilities and explain drifts or emerging patterns in the data [63], [64]. As a result, they require more advanced methods, skills, and product capabilities [53], [61]. *Predictive analytics* use past and current data to forecast future developments based on patterns in the existing data [64], [65]. Complex machine learning techniques are typically used to make these predictions [16], [62]. Based on these insights, *prescriptive analytics* can provide recommendations for actions to achieve desired outcomes [62], [65] by simulating possible actions and evaluating their impact on future developments [63], [64]. We consider services to be prescriptive only if the recommendations provided are not obvious from the predictive analysis. For example, a smart production line may collect usage data and predict the probability of a faulty soldering point. If it exceeds the threshold, an X-ray is performed to ensure the quality of the board. This decision is based on the probability and a simple binary decision of whether it exceeds the threshold and is therefore classified as only predictive (not prescriptive). The analytic capabilities each build on the functions of the preceding ones, moving from descriptive as the most basic to prescriptive as the most advanced capability encompassing all other capabilities [62]. In this dimension, taxonomy users should exclusively select the most advanced characteristic.

Acting features. We consider physical acting, digital acting, process triggering, and no acting as building blocks for smart services' achievement of desired outcomes. Smart services cross the boundary between the digital and physical worlds through actuators and use them to *physically act* and influence the product and its environment [50], [65]. For example, a modern harvesting machine's route and mode of operation can be automatically adjusted based on weather data [42]. *Digital actions* can include updating a car's software over the air [42] or displaying personalized advertisements on a smart monitor. These actions go beyond simply displaying monitored data or recommendations and directly affect the environment of the smart product user [5]. *Process triggering* describes a digital trigger of an action not performed by the smart product or a human operator as part of the inherent smart service. For example, a smart Kanban container could use a camera or scale and machine learning to assess the level of available parts and trigger an ordering process when the filling level is running low. Advanced smart services use an interplay of several of these capabilities to provide enhanced value-in-use. So, this dimension is not exclusive.

Information provision. Displaying information about the smart product or its environment is typically one of the key features of a smart service [1]. The smart service itself can trigger the provision of information (*push*), e.g., via notifications on a smartphone, tablet, or email when a particular threshold is exceeded [42]. Alternatively, the user of a smart service can initiate the provision of information themselves, which we refer to as *pull information*. For example, information may be accessed through a continuously available dashboard, a web service, or a retrievable report. Some smart services may not regularly provide information to the user as part of the offering, such as automation services or certain control services that provide limited or no information about what happens to or with the smart product during usage. In this case, *no* information is provided. For certain applications, the combination of push and pull information can be beneficial to draw additional attention to critical events. Therefore, the dimension is non-exclusive.

B. *Taxonomy Illustration*

To further test the taxonomy and demonstrate its usefulness for our subject, we show the application of our taxonomy in three exemplary use cases from our data set. The first case of a smart soap dispenser was briefly discussed in the introduction of this article (TABLE IV). Kimberley-Clark, a global provider of public restroom equipment, serves B2B customers, primarily facility managers responsible for maintaining clean and functional restrooms [66]. To provide smart services to its customers, Kimberley-Clark has integrated sensors and communication technology into its equipment to monitor the filling level of physical products (service provider: *smart product manufacturer*). The soap dispenser can send information about the remaining soap back to Kimberley-Clark, which uses this information to notify the customer (*push*) when the soap level falls below a predetermined threshold (*descriptive*) and needs to be refilled. This service provides *transparency* to the facility manager and enables *optimization* of the cleaning and replenishment schedule based on actual restroom usage. This is particularly beneficial in office environments, for example, where usage can vary significantly depending on occupancy, making it difficult to predict using traditional metrics and leading to unnecessary site visits. The facility manager receives *push* notifications and presents himself as the *provider of the smart product* (i.e., the soap dispenser) to his customers while being the target user of the smart service. The smart service is an *incremental improvement* because the main value proposition for the facility manager (the ability to provide clean restrooms with enough soap and paper towels to keep the restroom's users satisfied) remains the same but is enhanced by the improved scheduling possibilities. The service has *no acting features* other than informing the facility manager.

TABLE IV. Kimberley-Clark's monitoring of bathroom consumables

Dimension	Characteristics				E/N
Innovation Type	**Incremental Improvements**	Added Functionality	Radical New Offering		E
Smart Service Outcome	**Transparency**	**Optimization**	Remote Control	Autonomy	N
Service Provider	**Smart Product Manufacturer**	Retrofit Supplier	Smart Product Operator	External Partner	N
Target User	Smart Product User	**Smart Product Provider**	External Actor		N
Analytic Capabilities	**Descriptive**	Diagnostic	Predictive	Prescriptive	E
Acting Features	Physical	Digital	Process Triggering	**None**	N
Information Provision	**Push**	Pull	None		N

In the second case (TABLE V), an Italian government agency partnered with systems integrator ITI Sistemi (a *retrofit supplier*) to optimize the use of workplace resources and develop smart services for its offices [67], specifically to control the heating, ventilation, and air conditioning (HVAC) of the agency's meeting rooms. The solution developed by ITI Sistemi uses several sensors in the meeting room to assess its occupancy (*diagnostic*). When the rooms are unoccupied, and no meeting is scheduled, the HVAC system is *autonomously* turned off to reduce energy waste (*remote control*). The agency and its staff are not involved in this process, which means that the service does not provide transparency or optimization by our definition (both would require a human to use the information provided to make improvements). Therefore, we consider this service an *added functionality* rather than an incremental improvement since the automation is a major change to the overall system and usage processes. On the other hand, it is not a radically new offering because the primary value proposition—room temperature control—remains the same, and energy savings is a secondary concern.

TABLE V. ITI Sistemi's autonomous HVAC control

Dimension	Characteristics				E/N
Innovation Type	Incremental Improvements	Added Functionality	Radical New Offering		**E**
Smart Service Outcome	Transparency	Optimization	Remote Control	Autonomy	**N**
Service Provider	Smart Product Manufacturer	Retrofit Supplier	Smart Product Operator	External Partner	**N**
Target User	Smart Product User	Smart Product Provider	External Actor		**N**
Analytic Capabilities	Descriptive	Diagnostic	Predictive	Prescriptive	**E**
Acting Features	Physical	Digital	Process Triggering	None	**N**
Information Provision	Push	Pull	None		**N**

In the third case (TABLE VI), Airbus partnered with Accenture, a consulting firm that acts as the service provider and *retrofit supplier*, to use augmented reality glasses to simplify its assembly processes. These glasses act as smart products that augment information in the worker's field of vision to analyze their view and mark the aircraft's floor for seat installation. The glasses also provide additional information about the assembly process in real-time, with *diagnostic* capabilities that identify points of interest and take *digital actions* to mark those areas in the worker's field of view. In addition, workers can select the assembly step they are working on using voice commands or barcode scans to *pull* the information they need. The service outcome is advanced *transparency* into the assembly process and *optimization* through continuous training, which reduces error rates and improves productivity by up to 500 %. This smart service functionality goes beyond simple safety or prescription glasses. It is considered a *radical new offering* for Airbus, which uses the glasses specifically to take advantage of the augmented reality-based smart service.

TABLE VI. Accenture' assembly assistance through smart glasses

Dimension	Characteristics				E/N
Innovation Type	Incremental Improvements	Added Functionality	Radical New Offering		**E**
Smart Service Outcome	Transparency	Optimization	Remote Control	Autonomy	**N**
Service Provider	Smart Product Manufacturer	Retrofit Supplier	Smart Product Operator	External Partner	**N**
Target User	Smart Product User	Smart Product Provider	External Actor		**N**
Analytic Capabilities	Descriptive	Diagnostic	Predictive	Prescriptive	**E**
Acting Features	Physical	Digital	Process Triggering	None	**N**
Information Provision	Push	Pull	None		**N**

V. Discussion and Conclusion

In this article, we present a taxonomy for B2B smart services developed using the extended taxonomy design process proposed by Kundisch et al. [18] and methodological guidance from Nickerson et al. [19] to ensure a transparent and reproducible process. We conduct six design iterations, drawing on knowledge from the literature and real-world objects. This included a systematic literature review, following the process described by vom Brocke et al. [45], and an analysis of 100 publicly available B2B smart service use cases across diverse industries and application domains. Our design process also included feedback from a focus group and validation through inter-coder reliability testing of ten purposively sampled B2B smart service cases. These tests yielded an average hit ratio of 79 %, underscoring the validity of our findings.

The final taxonomy comprises seven dimensions—*innovation type*, *smart service outcome*, *service provider, target user*, *analytic capabilities*, *acting features*, and *information provision*—with corresponding characteristics. This taxonomy contributes descriptive knowledge to the smart service innovation literature by providing a structured way of describing and classifying B2B smart services. For instance, researchers can use this taxonomy as a common language and structure for analyzing, classifying, and configuring B2B smart services, thus filling a gap identified in previous studies. Our study of 100 B2B smart service use cases revealed that certain characteristics, such as *radically new offerings* and services with *autonomy* or *acting capabilities,* are currently underutilized. This presents opportunities for future research to validate our findings, explore the reasons for this underutilization, and derive actionable insights on how to promote the services with these characteristics.

As with any study, our research has limitations. We examine only publicly available practitioner case studies during the taxonomy development, which may miss more innovative services that are not yet fully implemented and communicated. Although we assessed a wide range of services from different industries, we cannot guarantee that we have covered every application domain or that our sample reflects the actual distribution of current market offerings. In addition, we acknowledge the interdependence of some characteristics of the dimensions (*smart service outcome*, *analytic capabilities*, and *acting features*). However, our results suggest that all dimensions are significantly relevant for describing B2B smart services and cannot be omitted. The innovation type dimension, with the lowest hit ratio of 65 %, may warrant further research to determine whether it is useful in its current form or needs modification. Finally, as with any taxonomy, our findings can only apply to the current environment of B2B smart services. As the field evolves, it will need to be regularly reviewed and may need to be updated if significant changes occur. Since our data collection process primarily relied on publicly available sources such as company websites and industry-specific business reports, the dataset is easily reproducible and extendable to reflect future developments.

While our study primarily targets researchers, we also provide valuable insights for practitioners. Managers can use our taxonomy to systematically categorize their current service offerings and gain a more structured view of their portfolio and target customers. The taxonomy can also help companies identify potential extensions to their offerings, such as a smart product manufacturer deciding to offer a smart service retrofit to attract more customers. This is particularly useful for companies looking to add B2B smart services to their portfolio and avoid commoditizing their offerings [3]. In future research, we aim to extend our findings by deriving a set of archetypes of B2B smart services that provide actionable blueprints for such services. The presented taxonomy already serves as a first step to reducing uncertainty and complexity in the development process and promoting smart service innovation.

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