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HOW TO CAPTURE UNCOMPLEX CUSTOMER SPECIFICATIONS FOR COMPLEX PRODUCT CO-CREATION: DESIGNING A TOOLKIT FOR THE B2B CONTEXT

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Abstract: *Product complexity is constantly increasing. Typically, complex products are co-created in time-consuming interactions, since intense explanation is needed. Although interaction and information costs between customers and manufacturers are relatively high, research suggests a consensus that such offerings are co-created most smoothly in face-to-face settings. However, it neglects how to capture the uncomplex specifications, also part of the required information. This appears promising to postpone the complex specification elicitation to the subsequent face-to-face co-creation process. Using media richness theory to explain this separation in a selective way, a toolkit is designed in cooperation with four B2B companies of the German high-tech textile industry. Following design-oriented research, we develop an artefact based on data derived from five focus groups with 17 participants in total. Our artefact is a use case diagram highlighting four identified functions. E.g., the function* specifying the final application of the product *is crucial with its implications for the overall process. Then, for one of the four companies, an artefact-based toolkit is demonstrated along the company's specific product portfolio specifications and its decision tree. For evaluating, seven in-depth interviews are conducted in the focal firm to help describe how the toolkit captures uncomplex specifications in complex product co-creation.*

Key Words: ***B2B co-creation, toolkits, complex products, design science research***

1. INTRODUCTION

While product complexity is constantly increasing, customers are getting involved more intensively in according co-creation processes [30, 39]. Complex products are typically co-created in personal and time-consuming interactions as they require intense explanation by experts from the manufacturer [9, 18, 34]. Hence, interaction and information costs between customers and manufacturers are comparably high [39]. Research suggests a consensus that such offerings are co-created most smoothly in face-to-face settings [1, 3, 12, 19, 24, 25, 34, 38, 55]. Looking through the lens of the media richness theory, the major reason is that high media richness such as face-to-face is best to address high information complexity in interactions [8, 10]. However, media richness theory also helps illustrate that extant research neglects how to capture the uncomplex specifications in complex product co-creation. Such uncomplex specifications are typically also part of the required information, and capturing them with digital technology in an effective way appears fruitful. Toolkits represent such a digital technology that is acknowledged for reducing interaction and information costs between customers and manufacturers [28, 29]. Therefore, the idea of this paper is to separate uncomplex from complex specification, explained by media richness theory [8, 10]. In other words: uncomplex product specifications are captured with a toolkit, and the complex specifications are postponed to the subsequent face-to-face co-creation process. This separation appears promising to better focus the subsequent process on complex issues, which promises a positive impact on the co-creation success [30, 40]. Efficient co-creation fosters both faster time to market and a reduction in costs [14, 37].

Although such toolkit approaches seem promising, related research on toolkit designs in domains with high product complexity is scant. Since the co-creation of complex products requires deep knowledge on the final application, several fields of expertise for their development, a wide breadth of knowledge and skills as well as a high number of customized components [30], co-creation processes in this domain are specifically challenging. Moreover, the introduction of digital technology comes with numerous pitfalls especially regarding complex offerings [12]. Several B2B companies have already experimented with digital technology for that purpose, mainly with configurators, which prerequisite a predefined solution space [23]. However, this becomes more difficult when dealing with an engineer-to-order context, i.e. a part of the offering is developed exclusively for one customer [18, 22]. These domains exhibit undefined solution spaces, which widely excludes traditional configurator approaches that allow for configuring and directly purchase the product after [16]. In other terms, we follow the assumption that parts of the product specification are so complex that it must be addressed with face-to-face settings [12], while a part of the specification is uncomplex and hence ascertainable with digital technology, i.e. a toolkit.

Looking at this task, several questions arise. For instance, what specifications are equally uncomplex and helpful for the manufacturer? How can they be captured with a toolkit? For answering these questions, we attempt to build an artefact that delivers concrete solutions to this task using design science research [26, 47]. This approach provides a clear structure of designing, demonstrating and evaluating and is particularly helpful due to its iterative, multi-cyclic adaptation of the toolkit while based in a real-life setting. Since extant research has not dealt with such approaches, our research is characterized by an explorative, qualitative paradigm. This is particularly useful for conceptual development and deep description of phenomena [11].

The study was carried out in cooperation with four B2B companies of the German high-tech textile industry. This industry deals with a particularly high degree of complexity with its narrow-specialized, cutting-edge technologies. It provides high-tech textiles for complex products and systems such as aerospace. Our artefact is based on data derived from five focus groups with 17 participants in total. Within the companies, both customers' and providers' views were covered to gather insights from both perspectives. Our artefact is a use case diagram which highlights four identified functions with expected benefits. For instance, the function *specifying the final application of the product* is crucial, as it comes with implications for the overall process. Another function relates to a pre-specified format that allows the customer to discover what uncomplex specifications he ideally has to deliver in the early phase in favor of an efficient process. Then, for one of the four companies, a toolkit is demonstrated along the company's specific product portfolio specifications and decision tree. Developing an instance for a specific case allowed gathering precise feedback by the participants because the demonstrated toolkit showed real-life examples without abstraction [26, 26]. For the evaluation part, seven in-depth interviews were conducted in the focal firm to help describe how the toolkit captures uncomplex specifications in complex product co-creation. Findings describe how the toolkit supports the overall process and what functions help in particular. Contribution to research relates particularly to calls for more research on tools that enable effective co-creation [4, 14]. We conclude by deriving managerial implications also for related industries that deal with high complexity and clarify what toolkit functions are likely to be translatable.

2. STATE-OF-THE-ART AND PROBLEM DEFINITION

2.1. Co-creation of complex products

Many integrated and customized components, different expertises as well as a high knowhow level characterize the requirements to create a complex product [30]. The complexity of such offerings is emphasized as a challenge already in early works, because capturing customers' specifications is a strong source of failure [24, 30, 31]. The co-creation of such products, defined as the active, creative and social collaboration process of customer and provider [48, 50], serves to elicit customer specifications to meet the individual needs [9, 15]. The co-creation process itself is facilitated by the provider [1, 48] and it is the task of the management to ensure its efficiency and efficacy [20].

Especially for complex products, co-creation appears suitable because the collaboration allows for eliciting also complex requirements that customers are not able to articulate explicitly [5, 27]. Complex products such as engineer-to-order [18], which typically come with an engineering part to every customer request, are exemplary for complexity because they prerequisite an intense customer-manufacturer interaction [34]. They need heavy explanation by the provider due to their intangible features and many, time-consuming interactions [9, 18, 34]. While this product complexity is constantly growing, customers are getting involved more intensively in according co-creation processes [30, 35, 39]. Hence, interaction and information costs between customers and manufacturers are comparably high [39]. Research suggests a consensus that such offerings are co-created most smoothly in face-to-face settings [1, 3, 12, 19, 24, 25, 34, 38, 55]. Furthermore, a recent study found that knowledge co-created in face-to-face settings is more valuable and insightful for companies [40].

One explanation for this need for face-to-face is delivered by the media richness theory, introduced by 8 [8] and refined by 10 [10]. Used also in other recent studies on co-creation [e. g. 40], this theory distinguishes different media along their dimension of richness and explains different media choices. Thereby, poor media such as mail are used for uncomplex, structured communication tasks, and rich media are used when uncertainty and equivocality are high. 8 [8] develop a model illustrating the task complexity and media richness, including also an ideal band with the corresponding effective media use. Outside of the band, the chosen media is either over-complicating or over-simplifying the task. Figure 1 illustrates the media richness theory based on 51 [51].

Looking through the lens of media richness theory, we argue that extant studies focus on how complex specifications are elicited in complex product development [1, 3, 12, 19, 24, 34, 38, 55]. But they neglect how the uncomplex specifications – typically also part of the process – are captured. In Figure 1, this shortcoming in the literature ranges in the lower area in the two-dimension matrix, i. e. low media richness and low task complexity. These areas are marked with stars:

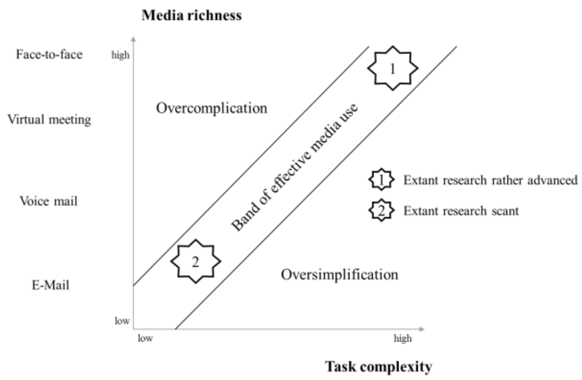

Fig. 1. *Media richness theory, model by [51]*

Before diving deeper, we draw attention to a question concerning the justification of this study: is there actually a need to focus on such uncomplex specification capturing with a toolkit? The question arises because in extant research, for instance in the area of mass customization, numerous studies deal with that topic of capturing uncomplex specifications with a toolkit [e. g. 13, 49]. One may argue that this area is well-researched, but we see two major differences as follows. First, current research does not address the question what specifications are uncomplex and helpful for the manufacturer, at the same time, in complex product co-creation. Therefore, in a selective way, this study addresses this balancing act.

Second, current research stresses difficulties in early phases considering complex co-creation. Finding a starting point to co-create is found quite problematic. For instance, 1 [1] found that, especially at the beginning, it is difficult to focus the process on relevant issues because there are so many details that hinder dealing only with complex issues. They further state that "suppliers felt that it is impossible even to start the process without information on the customer's needs, budget, schedule, usage, and business context." They consider such information a critical resource to start off. The authors also found that asking for the actual, underlying goal is useful instead of precise product specifications in complex co-creation. We consider suchlike information rather uncomplex and argue that a toolkit is suitable to ascertain it. As it requires low media richness, a toolkit is appropriate to capture this rather structured communication task.

2.2. Toolkits for complex products

Increasingly, digital technology is used to facilitate innovation processes [45], also in B2B [57]. This implies that the interaction between customer and manufacturer changes [42]. More precisely, the customer-manufacturer interaction has primarily been in face-to-face settings [3, 38], especially for complex products [52]. However, the interaction now occurs at different levels [12, 57]. Hence, the emergence of digital technologies in the sales process fundamentally changes established approaches and comes with major implications for the organization in charge of managing suchlike processes [20]. For instance, B2B portals assist employees and clients to have better decision-making capabilities through access to aggregated information [6]. Another early study deals with a choice menu with various features and options for configuring product specifications, which is found helpful in an early stage of customer involvement [36, 54].

As a form of digital technology, toolkits aim to reduce interaction and information costs between customers and manufacturers [28, 29], which makes them suitable for this study. Representing information systems provided by the manufacturer to their customers, they permit transferring customers' need information to the manufacturer and vice-versa transferring solution information. This study focuses on toolkits that specify customers' preferences, which we categorize as a precursor to the toolkits described in the literature as 'toolkits for customizing' [e.g. 44].

Hence, toolkits in this study target to capture uncomplex customer specifications, which allows for postponing the complex specification part to the face-to-face co-creation process. In total, we target a reduction of interaction and information costs by separating the uncomplex from the complex product specification, explained by means of the media richness theory [8]. In the current transition from innovation to digital innovation [45], this study focuses on the early phase of a complex product co-creation process by capturing uncomplex specifications with a toolkit. Also, tackling the problem described by 1 [1] that providers struggle to even start the process without information suchlike the usage or the business context, a toolkit captures this kind of information and therefore allows to inform this process upfront.

2.3. Problem definition

We advocate for the need of this study along a threefold problem definition. First, interaction and information costs between customers and manufacturers are comparably high [39], which hinders efficient co-creation. For better capturing customers requirement, providers use only face-to-face currently. Approaches to lower interaction and information costs, using digital technology, have not been exploited in the domain of complex product co-creation. Second, using media richness theory, we illustrated a research gap in the area of capturing uncomplex product specifications in complex product co-creation. This research gap is fueled by the need to start off the co-creation process with more information by the customer, otherwise providers struggle to find a starting point [1]. Hence, starting into the co-creation process in a more informed way appears fruitful, but also here, research is scant. Closely related, the third point concerns the question what specifications are equally uncomplex and helpful for the manufacturer to start off the process of complex product co-creation. A deeper understanding of this balancing act is highly promising to streamline the overall process supported by a toolkit.

In total, we argue that there is both a research gap and a literature-based motivation in capturing uncomplex customer specifications in complex product co-creation. Especially, we do not find studies that deal with approaches that allow for informing these processes upfront; neither can we identify an existing toolkit for our purposes.

3. RESEARCH APPROACH

This research aims at solving a problem in real-life, namely it seeks to capture uncomplex specifications in complex product co-creation. As we attempt to build an artefact that delivers concrete solutions to this task, we chose the design science research approach by 47 [47]. This approach provides a clear structure of designing, demonstrating and evaluating and is particularly helpful due to its iterative, multi-cyclic adaptation of the toolkit while based in a real-life setting. Since extant research has not dealt with such toolkit approaches, our research is coined by an explorative, qualitative paradigm. This is particularly useful for conceptual development and deep description of phenomena [11].

3.1. Field setting

Based in the German high-tech textile industry, this study was undertaken in cooperation with four companies specialized in different domains. All dealing with particular high product complexity, their business is characterized by joint development with customers. Hence, this branch heavily co-creates custom products, for instance for the aerospace sector. The complexity typically stems of intangible product attributes such as degree of fire resistance or acoustic insulation, whose peculiarities often need to be demonstrated and explained in face-to-face settings. We argue that this domain is most likely to benefit from a toolkit such as described in this paper. Companies subject of this paper are characterized by three commonalities as follows. First, high complexity is typically faced with one-to-one marketing. Hence, intense customer-manufacturer interactions serve to co-create the offering. Second, they provide mainly complex offerings for industrial customers, for which one part is typically co-created. Thirdly, there are no supporting toolkits in the process. The data for this study was gathered in these four companies, for which we provide additional information in *Table 1*.

3.2. Artefact development & data collection

In order to design our toolkit, we followed the design science research approach by 47 [47]. Illustrated in *Figure 1,* this approach combines a clear structure of designing, demonstrating and evaluating while being based in a real-life setting.

For the design and artefact development, we conducted five focus groups within the scope of a research project. This three-year project spanned across the entire industry of our empirical field and allowed us to involve four companies in the focus groups. Focus groups are particularly helpful to foster dynamic discussions among the participants, allowing for group interaction [33]. For this study's purposes, this appeared suitable because we attempted to elicit innovative approaches for exploiting digital technology in complex product co-creation. We involved four to six participants, in line with recommended practice [43]. Participants were supposed to discuss a series of open questions derived from the problem definition (see *2.3. Problem definition*). The composition of the group included sales managers as well as procurement managers (see *Table 1*), integrating both perspectives, the provider's and the customer's view, in the focus groups. All focus groups were recorded and transcribed verbatim.

In a final presentation, where every company was invited, we presented a first version of the artefact with its functions to mirror the objectives derived from the focus groups. With a slightly improved version, the artefact was used to set up a toolkit for one of the participating companies. This allowed building the toolkit for this company's specific product portfolio and internal decision tree. Utilizing data from the focal company is helpful in order to gather unfiltered feedback as interviewees are able to directly relate the content to their firm. Hence, we sought to reduce abstraction which is helpful in search of greater relevance due to the use of 'unfiltered and real' rather than artificial contexts [21, 26].

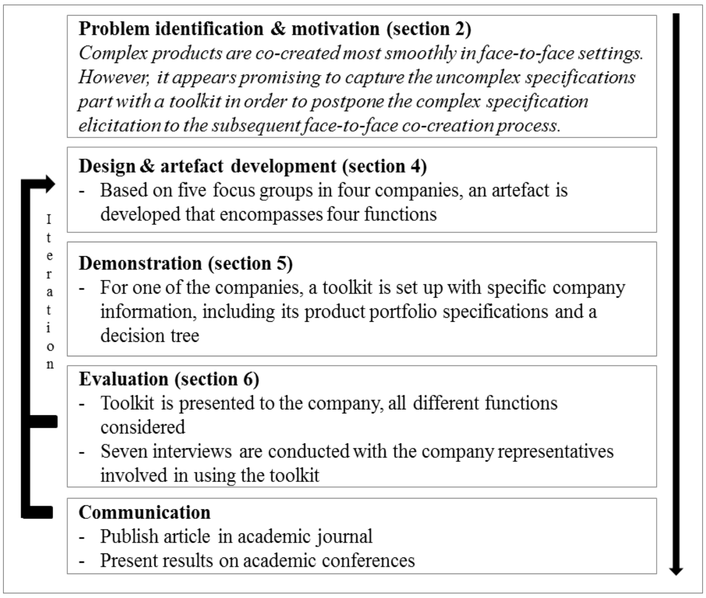

Fig. 2. *Set up the toolkit following [47]*

For evaluating, seven interviews were conducted in the focal company, following a purposeful sampling approach [46]. The selection of both the focus group participants as well as the interviewees included the Technical Director, Head of Sales, Procurement Manager and Sales Managers, all experienced (>10 years working experience in this domain) to feedback the toolkit to explore whether it really facilitates their daily work in direct comparison. Also here, both perspectives of customer and provider have been taken into account. The artefact and toolkit were iteratively improved and extended by constantly integrating the feedback [56]. Interviewees were also supposed to elaborate on their impressions with notes afterwards, and then their additional feedback was collected in short follow-up interviews. All data for this study has been recorded and transcribed. An overview of the four companies and data is given in *Table 1*.

3.3. Data analysis

Since extant research has not dealt with such approaches as described in this paper, our research is characterized by an explorative, qualitative paradigm. This is particularly useful for conceptual development and deep description of phenomena [11]. Our analysis includes data from focus groups as well as semi-structured face-to-face interviews that followed the demonstration of the toolkit, conducted by this study's researcher. For both focus groups and interviews, a qualitative data analysis was based on the coding procedure suggested by 7 [7], deviating mainly regarding the underlying goal. Hence, the focus group analysis targeted the artefact development for uncovering and describing the functions, while the interviews served to deeply understand how the toolkit serves to ease co-creation processes with complex products. We assumed multiple phenomena to explore, which is why we organized data analysis flexibly, following the constant comparative method by 17 [17]. Overall, in our analysis, we focused on our goal of capturing uncomplex product specifications only and excluded features that were also considered useful, such as flawless repurchase etc., since they are not related to co-creation activities.

For analyzing the data of the focus groups, the coding procedure by 7 [7] was utilized. With the goals of this study and problems defined (see *2.3 Problem definition*), initial codes were defined by the two researchers involved in this study. Then, we expanded the code list and targeted the functions of the artefact, condensing the data by constantly comparing and iterating the focus group data with extant research [17, 41]. Thereby, both induction and deduction were combined in our qualitative research for the artefact development [17]. The data analysis of the one-on-one interviews for the evaluation part followed the same procedure on a theoretical level, but the goal was fundamentally different. We aimed at unmasking and deeper understanding the benefits and pitfalls of the artefact-based toolkit. More precisely, we touched upon the four functions of the artefact to set up the initial codes that have been revised and expanded afterwards. For triangulation purposes, we also fed back data gathered from short follow-up interviews, that we conducted a couple of weeks after the personal interviews.

Table 1. *Overview of companies & data for this study*

Brief description	Involved persons	Position of interviewee	Employees	Method used and quantity	Data amount
-focal company where toolkit was evaluated- Manufacturer of coated fabrics with specific functions, e.g., tear-proof, heat-resistant, cold-resistant, embossment	7	CEO, Technical Director, Head of Sales, Procurement Manager, Sales Managers	250	Two focus groups, seven interviews	237 min focus groups, 434 min interviews
High-quality fabric manufacturer with specific functions for indoor use, e.g., acoustic insulating and fireproof	4	CEO, Technical Director, Procurement Manager	50	One focus group	138 min
Manufacturer of yarn for technical textiles with specific functions, e.g., tensile strength, heat- & cold-resistant	4	CEO, Senior Development Manager, Sales Manager	100	One focus group	161 min
Service provider for technical textiles, adding specific functions, e.g., water-resistant, fireproof	4	CEO, Chief Developer, Sales Manager, Procurement Manager	100	One focus group	122 min

4. DESIGN & ARTEFACT DEVELOPMENT

Complex products are co-created most smoothly in time-consuming and often inefficient interactions. It is the goal of this study to capture uncomplex specifications in order to postpone complex decisions to the face-to-face settings, which are best to face high complexity. For the artefact development, we used data from five focus groups. Various functions and requirements were identified. The artefact is a use case diagram that highlights the four functions identified with expected benefits (*Figure 3)*. We also expose the order for the functions. A closer description with underpinning data derived from the focus groups follows.

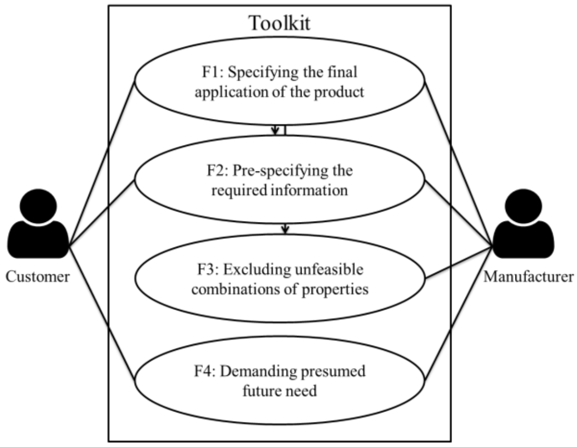

Fig. 3. *Use case diagram perspective of the artefact*

The use case diagram perspective is a tool for illustrating the functional requirements of a system that allows the inclusion of various stakeholders [53]. It thus serves to illustrate both sides and links the examined functions with both parties that are involved in the co-creation process. While our main focus was on the provider's perspective, expected benefits for the customer were likewise taken into account, covering both sides with interviews in the four companies. In the use case diagram, secondary functions such as *Create customer account* or *Login to customer account*, typically also exhibited in use case diagrams for the sake of completeness, are excluded for better clarity and mere focus on this paper's goal. The connections illustrate the function and the access by the customer or manufacturer. All functions are listed and delineated in *Table 2*, afterwards deeper described and flanked by evidence drawn from our data.

Table 2. *Function description of the artefact*

Function	Description and expected benefit
F1: Specifying the final application of the product	The application allows drawing conclusions on specific requirements or audits (e. g. environment, public or private).
F2: Pre-specifying the required information	With a pre-specified format, the customer knows what specifications he ideally has to deliver in the early phase.
F3: Excluding unfeasible combinations of properties	In order to avoid technologically unfeasible customer demands in the first step, several combinations of properties are excluded.
F4: Demanding presumed future need	In order to avoid organizationally unfeasible customer demands in the first step, customers are demanded the approx. quantity, asking price and delivery date.

4.1. F1: Specifying the final application of the product

The first function identified refers to the final application of the product. Since its specification provides information on a variety of factors and determines requirements and audits, the final application plays a crucial role at the outset of the co-creation process. As was repeatedly pointed out during the focus groups, the whole process can only commence when the manufacturer has access to this information:

Janko, Sales Manager: "Only when the customer tells us where he uses the product in the end, then we can start the joint development process, because this information narrows down the possible solutions in the early stage."

The final application not only limits possible solutions, but also allows drawing conclusions on specific requirements that are linked with application purposes. The environment in which a product will be used determines which parameters are being contemplated. For instance, a significant difference between public and private application was stressed throughout the focus groups, which can impact the required audits:

Kerstin, Technical Director: "But sometimes an [application] area excludes or influences so many things that it is of enormous importance to know the application purpose for starters. Whether it is cruise ships or interior space where I need certain audits. For instance B1, particularly flame-resistant. In public areas I need B1."

Specifying the product's final application at an early stage is thus considered to be of great relevance, because it affects numerous factors and therefore offers a lot of information that are necessary for a successful co-creation. As became apparent, the final application is at the core of uncomplex specifications because it is clearly a task that customers are capable to articulate. With regard to its pivotal role, it is expected to necessarily be captured at the very beginning.

4.2. F2: Pre-specifying the required information

The second important function relates to demonstrating which information is required from the customer. Which specifications the customer needs to deliver highly depends on the context in which the product will finally be utilized. On this account, the pre-specification of required information builds upon the final product application, as indicated by an arrow in *Figure 3*. Flame resistance, for instance, is typically required for the application of a product in public areas, while in other application contexts the presence of this quality is irrelevant. The predetermined format precisely shows which specifications are expected from the customer domain. A clear structure is found likely to enable customers to know which information they ideally have to deliver in the early phase. Apart from the final application, various additional factors must be decided upon. Since demands are primarily received via mail, they run into danger of lacking crucial information. Equally important, customers often tend to overload demands with irrelevant pieces of information:

Hanno, Procurement Manger: "Sure, I just upload everything in a project that I have and then they might have like 25 attachments, for which 2 are relevant eventually. But how do I know?"

Dispensing with irrelevant information potentially saves time and helps prevent mistakes that are caused by an overload of unstructured information. Equipping the toolkit with a clear structure is instead regarded to enable customers to better grasp the necessity of information to provide, since requests become more useful with better understanding:

Bert, CEO: "The more our customers know, the better they can prepare or the better the documents they upload."

Also in the event of overloaded requests, key information is not included necessarily. While blank spots are permitted in some places, which allows for postponing these decisions, other information is crucial for the assessment of requirements or cost effectiveness. A pre-specified modular composition is found useful to enable customers to recognize missing pieces of information, while at the same time organizing the received request in a pre-specified and more transparent format instead of unstructured emails.

4.3 F3: Excluding unfeasible combinations of properties

A lot of specifications are only available or relevant to certain applications, which makes capturing them redundant, or even inconsistent, after they have already been disqualified in the course of selecting a different final application:

Kerstin, Technical Director: "These are areas that place very different demands on the textile. The one, for example, in the normal area needs to be hard-wearing, but must not be UV-resistant or cold-resistant. Boat imitation leather on the other hand must be UV-resistant, must not get moldy, but doesn't need to be cold-resistant."

Similar to the pre-specification of required information, the exclusion of unfeasible or irrelevant properties can also be based on the final product application (see arrow from *F1* to *F3* in *Figure 3*). Taking the pre-specification one step further, the preselection of properties that should be taken into account by the customer not only suggests appropriate qualities, but also rules out inappropriate ones. The same principle applies to combining certain properties that are either unfeasible or pointless, such as the combination of, e.g., two conflicting quality requirements "flame resistance" and "water resistance". It is hence considered a great benefit to exclude several properties according to either the final application or other selected features in an early phase. This function serves to avoid technologically unfeasible customer demands that are automatically prevented. As became clear from the focus groups, this technique is to some extent also implemented in other systems used by some of the researched companies:

Anja, Head of Sales: "We just have a list […]. There you can choose types and then you have drop down lists which objects are available for that."

It is expected that the exclusion of unfeasible property combinations on the one hand facilitates the whole specification procedure. At the same time, incorrect specifications are prevented from the start, which can increase efficiency and entail cost savings for both provider and customer.

4.4 F4: Demanding presumed future need

Although not necessarily related to the co-creation of complex products, we encountered another interesting point in our data. Besides the specification of final application and properties, all concerning the complex product itself, the provider stresses the need for further information for a possible assessment of customer's wishes. Apart from being feasible in terms of production technology, technically feasible requests must in addition be organizationally feasible, in case that the customer is willing to order eventually. Allowing providers to perform a rough organizational calculation upfront is vital for identifying products that run into danger of being unrealizable. This is particularly relevant for complex products because subsequent personal co-creation sessions are time-consuming and require high interaction costs [39]. Moreover, such co-creation projects can span over a couple of years. Before starting the co-creation, it must be appraised beforehand if there is a basis for efficient and successful solution development. Conversely, stakeholders seem to be regularly confronted with discovering the unfeasibility of customer demands only later on. Hence, it is of relevance to ensure that the customer provides his presumed future need that allows a rough organizational calculation upfront:

Hans, Senior Development Manager: "Then it's also you would like to have some ideas about expected financial expectations overall. Let's say business case expectations from the customer […]. Or let's say just simply pricing information that they are looking for."

Throughout the focus groups, practitioners expressed a necessity to receive presumed future need by the customer at an early stage, which includes approximated quantity, asking price and rough date of possible delivery. Such uncomplex need is useful for an initial appraisal of financial capabilities and scale.

Benno, Sales Manager: "You try to get some information about financial capability, brands when they are planning to do something."

In that sense, it would appear essential to collect additional information to identify unfeasible requests right from the start. Both provider and customer are expected to profit from this function that serves to spare them futile effort. It is considered in the interests of customers that their expectations are accurately assessed by the provider. Because such additional information is only evaluated in connection with the product specification and requires a rather high degree of commitment from the customer, this kind of information should be requested at last.

5. DEMONSTRATING THE TOOLKIT

A final version of the artefact with its four described functions was translated into a toolkit. It aims at obtaining all the required information, while minimizing the effort for the customer and remaining manageable and clearly structured. We demonstrate the toolkit for one of the four participating companies by using their decision tree and product portfolio data. This allows the subsequent evaluation part to present a toolkit fed with real-life data. Hence, the interviewees will be shown a non-abstract toolkit with their known company data, avoiding abstraction biases.

The architecture of the toolkit follows a modular system that demands the required information step by step with the abovementioned artefact functions. In compliance with *F1: Specifying the final application of the product*, the piece of information collected at first is the final application of the product. As part of the same section, two other general properties that offer considerable informative value in the textile sector are set: composite and textile carrier. A second section entitled "Further properties" allows the additional selection of quality requirements that can easily be marked. Both the modular system and the pre-definition of a series of further properties are based on function *F2: Pre-specifying the required information*. In order to provide less experienced customers with additional information without complicating the request form for the more experienced ones, small information buttons are displayed next to each property that show explanations when hovering over them. In accordance with function *F3: Excluding unfeasible combinations of properties*, the selection of some parameters automatically excludes others (e.g. choosing "flame resistance" as a quality requirement automatically greys out the option "water resistance"). Likewise, inappropriate properties are ruled out on the basis of the specified final application of the product. Technical specifications such as technology, machine use and product group are derived from these requirements in a following step. In the lower part of the screen, the standardized form is complemented by an empty field that allows the insert of any further information. In addition to that, the toolkit allows for the upload of any kind of additional document such as photograph or measurement sheet. Consistent with *F4: Demanding presumed future need* data that allow a rough organizational calculation, such as quantity, asking price and requested date of delivery, complete the form. A screenshot of the toolkit is displayed below in *Figure 4*. The other tabs on top such as "Customer data" or "Order tracking" are not at the center of interest for this study, as they do not concern the uncomplex specification capturing.

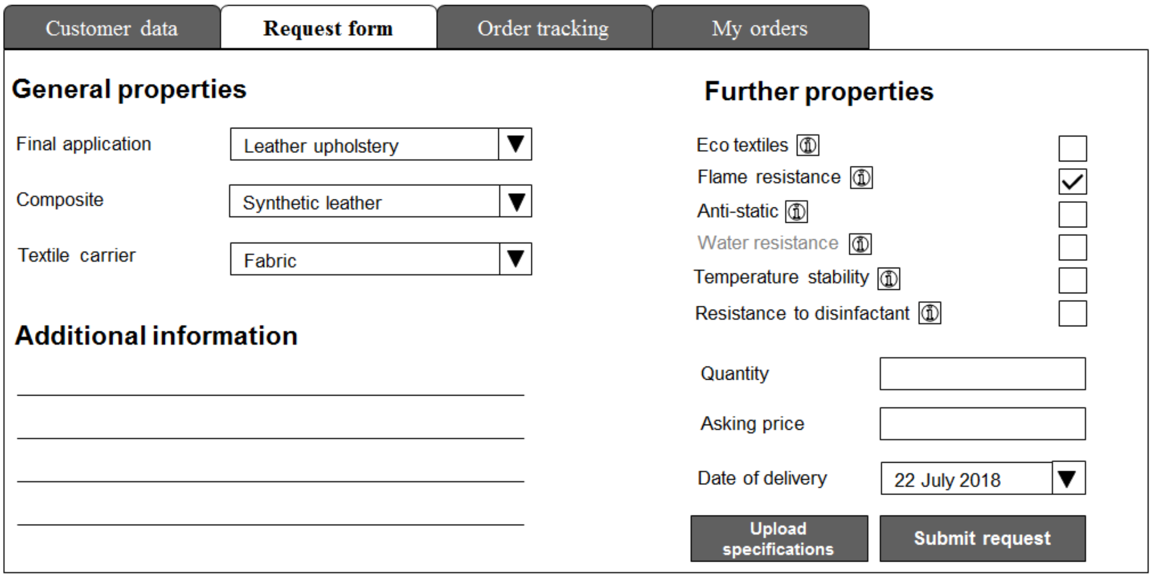

Fig. 4. *Screenshot of the toolkit's "Request form"*

6. EVALUATING THE ARTEFACT

In general, the toolkit was considered effective by the practitioners involved. A closer look at the four functions of the artefact, however, allows a more differentiated assessment to which extent and due to which functions precisely the toolkit can streamline their daily work in practice.

6.1 F1: Specifying the final application of the product

First of all, *F1: Specifying the final application of the product* was regarded an essential feature by the interviewees from the provider's site. Consistently, it was stressed that further emphasis needs to be put on the final application as a key component that determines various factors, such as quality requirements or stakeholders to involve in the subsequent face-to-face co-creation. In line with our suggested order of the functions, the necessity to select the final application at the first place was confirmed:

Kerstin, Technical Director: "The first step is always to look at the application purpose. Upholstery is different from car for example. So that's really the first issue the toolkit has to come up with."

Moreover, the role that the final application can play for the two functions *F2: Pre-specifying the required information* and *F3: Excluding unfeasible combinations of properties* was approved. It was considered particularly practical to further tailor the request form to specific needs that can be derived from the application context on the basis of the defined final application.

6.2 F2: Pre-specifying the required information

Likewise, artefact function *F2: Pre-specifying the required information* was highly supported throughout the database, including both procurement and sales managers. Giving customers a clear structure and allowing them insight into which specifications are expected from them turned out to increase transparency. Furthermore, the pre-structuring of relevant information was considered useful for a facilitated processing of information prior to the face-to-face co-creation:

Janko, Sales Manager: "The idea is that we [the salesperson] can already submit the protocol or summary to the application engineer and then just say to them 'you must only wait for the sample and can already have a look at the rest'. It's a great and smooth preparation that we usually don't have"

However, our data also exhibit doubt whether this form is capable of preventing an information overload by the customer. While revealing blank spots and structuring the expected information, the toolkit still offers room for the unassisted upload of freely selected documents of any scale and complexity. Apparently, customers frequently communicate irrelevant details as a strategy to forestall the possibility of missing relevant information. This seems to be the case especially for less experienced customers. Two of the interviewees from the customer and provider shed light on the problem:

Sascha, Procurement Manager: "If you don't know much you just upload everything then you make sure you can't miss relevant stuff. Later the company can just pick what they need."

Horst, Technical Director: "I would fear that inexperienced customers would just feed that platform with everything that they have even though it's not relevant."

This problem indicates a trade-off between flexibility and structure. Although allowing customers to upload additional pieces of information self-reliantly can be beneficial, it also holds the danger of losing their plain, pre-defined structure. The problem illustrates the necessity of flexibility when co-creating complex products. Besides, structuring the specifications that are required can encourage the customer to take necessary decisions instead of postponing them:

Bert, CEO: "I understand the customer can also be more certain when he is committing some configuration choices. 'Okay, now I have to commit these kinds of choices and I can only specify two.' And then we can work with that […] and then there isn't this back and forth changing all the time."

Making choices is considered as a form of commitment for which customers must previously make up their mind about desires and own expectations for the co-creation of complex products. Decisions are expected to ensure a high degree of continuity and thus facilitate the co-creation process. Since continuous changing choices adversely affect the whole co-creation, a structure that encourages decisions is capable of increasing efficiency and efficacy, which is beneficial for customers as well as providers.

6.3 F3: Excluding unfeasible combinations of properties

The toolkit not only allows the customer insight into the required information but also into the feasibility of combinations, in line with function *F3: Excluding unfeasible combinations of properties*. As expressed throughout the interviews, the involved stakeholders often face a gap between individual customer requirements and provider's capabilities.

Anja, Head of Sales: "Or if the customer... what often is the case, the customer comes with the layout which does not fit or we calculate load exceedances and discover that what the customer plans and expects is not possible from our side."

The difference between what the customer expects and what the provider is actually capable to deliver presents a challenge for the face-to-face co-creation. This holds particularly true for complex products as their development is highly complicated. Excluding the possibility of technological unfeasibility seems promising before stakeholders meet up in person. Thus, certain combinations are ruled out upfront, which is considered to be advantageous for both provider and customer. Although it is expected that some requests are eliminated directly in advance due to unfeasibility, without personal touchpoints at all, interaction and information costs between customers and manufacturers are likely to be lowered in many cases.

6.4 F4: Demanding presumed future need

This function was described as useful primarily for the provider. It was expected that some requests would be eliminated due to customer information regarding potential delivery data, price indication etc., hence firm criteria based on customers' plans for the successfully co-created product. Also here, it appears promising to exclude unfeasible wishes, which promises lower interaction costs for the benefit of the providing company. The importance of receiving presumed future need at last could not be confirmed. Instead, a difference between written and non-written form was stressed for presumed future need in particular. Written documents were regarded to ensure a high level of transparency, which is why this form was clearly preferred to receiving such information on the phone or in person:

Hans, Sales Manager: "Business information as much as they can share is also welcome to get in written form. Also if there are some special legal requirements, limitations, that's all the best to get in written form because you have then a clear follow up reference."

6.5 Integrating the artefact & remarks

For concluding this section, the four artefact-based functions of the toolkit partially proved useful for capturing uncomplex specifications in complex product co-creation. In essence, the toolkit performs the task of conciliating expectations and requirements from both customer's and provider's side, while at the same time eliminating cases in which they cannot be brought together. While function *F1: Specifying final application* and *F4: Demanding presumed future need* mainly serve the purpose of eliciting what the customer requires, *F2: Pre-specifying the required information* and *F3: Excluding unfeasible combinations* predominantly concern the provider's resources. In total, we advocate for the usefulness of the artefact as it allows making sure that both sides involved in the co-creation are provided with an initial overview of which possibilities the subsequent face-to-face co-creation holds. The provided structure further serves to organize expectations and requirements and thereby focuses the subsequent face-to-face part. Besides interlinking the involved stakeholders with each other more closely and accelerating co-creation processes for complex products, it also rules out unfeasible combinations in an early phase.

One major problem that became apparent in the evaluation part, however, touches upon the variety of customer types. It turned out that the difference between experienced and inexperienced customers plays a considerable role for the artefact:

Anja, Head of Sales: "But we are having customer contact every day with several types of customers but the experienced ones […] and there we are like it's a big team playing yet. So they know what we need from them and we know what we can get as information and also what they expect from us."

With regular customers, repeated co-creation projects have already been carried out, needing far less coordination and customer enabling. Since it can be assumed that reciprocal expectations have been adapted to each other's capabilities, the way that the toolkit streamlines the process may differ from co-creation with other customers.

7. CONCLUSION

This study reported on designing a B2B toolkit that supports the co-creation of complex offerings in the German textile industry. Drawing upon a series of focus groups, we uncovered an artefact with four functions that appeared promising for the purpose of capturing uncomplex product specifications in complex product co-creation. Following a design science research approach, we translated the artefact into a toolkit and demonstrated it. It was set up along the specific product portfolio of one focal company in our field. Seven interviews served to evaluate the artefact, involving both the customer and provider view on the subject. Our findings suggest that such an artefact and toolkit is useful for separating the uncomplex specification capturing from the complex elicitation of product specifications, which is done most smoothly using the richest media, namely face-to-face.

7.1 Contribution to research

The study's theoretical contribution is two-fold. First, it adds valuable insights to the under researched field of B2B co-creation (2) and follows recent calls for studies in the field of practice-based research on co-creation (32). In particular, our findings relate to the highly complex ETO context, in which the solution space is not defined upfront, which disqualifies present configurator approaches [16]. Second, in addition to such contributions to literature on B2B customization and co-creation, we propose an innovative B2B toolkit that is based on an artefact developed using design science research (47). Relating to calls for further research on tools which support effective co-creation [4, 14], its design provides fruitful insights into mastering complexity with toolkits. The study especially addresses the elicitation of uncomplex specifications that are considered fundamental for being able to start off complex product co-creation (1). Our findings shed light on the scarcely explored question as to which specifications are both uncomplex and still useful for the provider in complex product co-creation.

7.2 Managerial implications

A high degree of complexity is particularly dealt with in specialized companies. Specifically, these companies as well as generally companies that face high complexity benefit from this study's findings. Drawing on interviews that refer back to a practice-oriented basis with strong application orientation, the suggested toolkit expands the understanding on how co-creation processes can be supported upfront. In practical application, our findings help companies to support face-to-face co-creation by allowing for a better preparation upfront for both customer and provider. According to our data, toolkits with the identified functions provide a structure that helps to focus the subsequent face-to-face interaction by interlinking the involved stakeholders and their expectations more closely with each other. For instance, toolkit approaches as proposed serve to filter out unfeasible requests in the early stages. Our research demonstrates that a toolkit with the identified functions is capable of meeting the challenge of bridging the gap between the customer's expectations and the provider's capabilities that face-to-face co-creation is typically facing. We argue that the suggested benefit of a pre-specification of resources and requirements is likely to hold true also for other industries dealing with high product complexity.

7.3 Limitations & further research

Following a design-oriented approach that is to some extent tailored to the specific conditions in the examined industry, our findings are subject to a threefold limitation. First, our research focused on the German high-tech industry, in which haptic features are of particular importance. Consequently, the results are rather applicable to industries that also require face-to-face interaction throughout the co-creation process. Further research is therefore needed to examine which of the described functions and benefits of the toolkit can be transferred to other B2B contexts that dispense with face-to-face co-creation. Second, although the interviewed procurement managers were well placed to take the customer's perspective, it might in addition be fruitful to enrich the information base with richer customer insight, especially since we stress a necessity to examine the toolkit's utilization across various customer types. Finally, the implementation remained limited to a visual representation without technical realization in the company's existing information technology landscape. Hence, further research and testing should involve the technical implementation of the toolkit in order to complement our findings with insights into its operational handling within productive environments.

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