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Design Thinking Methods for Service Innovation - A Delphi Study -

Completed Research Paper

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Abstract

As our world is getting increasingly servitized and digitized, innovation is no longer bound to physical products. Customer experience and innovative services have become the new imperative for business success. Design Thinking is becoming a valid approach for service innovation in the digital age. However, a profound understanding of “how” Design Thinking contributes to service innovation is still missing. We show this by conducting a Delphi study which includes 14 Design Thinking experts across different company sizes and industries. As a result, we demonstrate consensus on 59 highly relevant methods for service innovation allocated to the respective Design Thinking phase. This is the first study to provide a comprehensive view on Design Thinking methods for service innovation. We enhance the understanding of Design Thinking and lay the foundation for further investigations into the service innovation process. Practitioners receive guidance from our findings for applying those methods.

Keywords: Smart Service Innovation, Service Design, Design Thinking, Delphi Study

Introduction

As our world is getting increasingly more servitized and digitized, innovation is no longer solely restricted to physical products and their functionality. To address the rising demands for a highly individualized and outstanding user experience for customers and to offer them exactly what, where, and when they want it (Setia et al. 2013), innovative service offerings have become the new imperative for business success in the digital age (Nambisan et al. 2016; Yoo et al. 2010).

Traditionally, product design focused on the release of new, hardly modifiable products within designated product generations, whose design was inflexible until a new generation was introduced. Product development mainly followed sequential design approaches; customers were barely included in the design process in the past. With the trend of servitization (Baines et al. 2009), this perspective has changed, and service has become the new normal in a world, in which products are now understood as platforms offering services. Incorporating digital technology into physical products

brings them to life and allows for their digital properties to be continually updated over-the-air (Porter and Heppelmann 2014). The Tesla autopilot is a good example, facilitating an entirely new user experience based on a software update of a physical product.

In a rapidly changing environment, more and more companies deploy new service offerings in increasingly shorter release cycles to address the rising demands of customers for novel and more individualized service experiences (Setia et al. 2013). Keeping up with this pace of change, is one of the top priorities for business leaders around the globe (Kane et al. 2015). Thus, when designing innovative service offerings, agile working methods are required (Hippel 2005), as well as a strong focus on human- and customer orientation (Brenner et al. 2014; Brown 2009). In this context, Design Thinking as a “set of broad approaches to organizational problem solving and innovation that are based on the tradition of human-centered design practices” (Yoo 2017, p. iv) has grown into one of the most popular methodologies, since it creates digital (service) innovation by considering actual customer needs (Kolko 2015; Martin 2009). Furthermore, its iterative nature allows to quickly adapt to changing consumer demands as well. The realization of Design Thinking is often achieved via prescriptive process models, that put the innovation efforts into a logical sequence of steps and activities. The commonly applied process framework by the Stanford University includes the phases problem definition, needfinding, synthesis, ideation, prototyping, and testing (ME310 2010).

Against this background, large corporations like Deutsche Bank (Vetterli et al. 2016), IBM (Lohr 2015), Apple (Thomke and Feinberg 2009), and Samsung (Yoo and Kim 2015) have been implementing Design Thinking to enhance their service innovation activities. Existing academic studies encourage these efforts and affirm Design Thinking to be a valuable method for service innovation (e.g., Barrett et al. 2015). However, despite the practical and theoretical advances to confirm its potential benefit, knowledge on how Design Thinking contributes to service innovation still remains unclear. The theoretical foundation must gain a more comprehensive understanding than given at present in order to meet the demands of Yoo (2017) to apply Design Thinking in IS research and to guide companies in practice in a more meaningful way (Kimbell 2012).

In order to close the existing research gap and generate empirical evidence on “how” Design Thinking adds to service innovation, we want to provide an in-depth understanding and analysis of the most relevant methods for service innovation in each Design Thinking phase. In this context, we define the term method as a technique or a tool to support a goal or sub-goal of one or many Design Thinking phases (Brenner et al. 2016).

Hence, our study addresses the following research questions:

RQ1: What are the most important Design Thinking methods for service innovation?

RQ2: How does Design Thinking contribute to service innovation?

We approach these questions by conducting a Delphi study, which includes 14 Design Thinking experts across different company sizes and industries. This study focuses on the exploration of methods used in Design Thinking to design innovative service offerings in the digital age. As a result, we can present expert consensus on 59 highly relevant methods for service innovation for each Design Thinking phase. To provide detailed explanations about how and when to apply these methods best, we classify the methods allocating them to the respective Design Thinking phases. Our research findings not only contribute to extending the theoretical foundation of Design Thinking for service innovation, but also provide information for practitioners about the most important Design Thinking methods that can, if acted upon, enhance a human-centered approach to problem-solving for service generation.

This paper is organized as follows. The subsequent section introduces service innovation and the concept of Design Thinking. Then, a detailed description of our Delphi analysis is presented, followed by our findings regarding the most relevant Design Thinking methods for service innovation. Later, we will turn to a discussion of our results and demonstrate how Design Thinking methods contribute to service innovation. We point out our contribution to research and practice and reflect on its limitations and suggestions for further research in the last section.

Research background

Service Innovation

In today's service-driven economy, innovative service offerings become increasingly important. Although research on the design of innovative service offerings is scarce, service innovation literature recognizes the interdisciplinary and human-centered nature of the service design process (Barrett et al. 2015). In addition, research on service systems engineering identifies a lack of design knowledge and design methodologies for innovative service offerings (Böhmman et al. 2014). The concept of *smart* service systems is on the rise conceptualizing systems capable of learning, dynamic adaption, and decision making based on data (Maglio 2015). Enabled by digital technology, smart service systems are socio-technical systems that require to take into account the needs of actors in the service ecosystem. Existing research largely omits to take the needs of the users of beneficiaries into account from early on when designing the service (Maglio 2015).

According to the Service-Dominant Logic (SDL) as an underpinning theory, the value of a service offering is exclusively determined by the satisfaction of the beneficiary (Lusch and Nambisan 2015). Building on this foundation, Lusch and Nambisan (2015) provide a tripartite framework for service innovation consisting of (1) service ecosystems, (2) service platforms, and (3) value co-creation. The three elements of service innovation are particularly important when designing services. First, service ecosystems address the mix of complementing actors that are willing to integrate resources. Second, the service platform allows actors to pool resources. Third, value co-creation are the processes and activities in which actors in the service ecosystem integrate resources (Lusch and Namibisan 2015). Design Thinking is identified as an influential practice to design innovative services and specifically service ecosystems, service platforms, and the way how value is co-created. It is understood as an exploratory process with the goal of creating new value relations between various actors (Barrett et al. 2015; Kimbell 2011). As systematic service innovation becomes important for actors to differentiate their offerings from competitors, new methods and tools, like Design Thinking, are required to systematically design or engineer innovative service offerings (Maglio 2015; Barrett et al. 2015).

Design Thinking

The origins of Design Thinking root back to the late 1960s when scientists like (Simon 1996) discovered that design goes beyond the aesthetics of products towards a way of thinking and doing. Over time three lenses on Design Thinking emerged (Kimbell 2011): (1) Design Thinking as a cognitive style with a clear focus on the individual and their capabilities (Dorst 2010), (2) Design Thinking as a general theory of design, seeing Design as a discipline for solving wicked problems (Buchanan 1992), and lastly, (3) Design Thinking as an organizational resource for business with a strong focus on creating and developing innovative outcomes (Brown 2008).

This study is based on the popular and widely used Design Thinking approach of the Stanford University, the so called ME310 program that laid the foundation for more specialized Design Thinking approaches following after (Dolata et al. 2016). The Stanford ME310 process model consists of six consecutive steps (ME310 2010). The mission in the first two steps is to understand and explore the problem space (1 - Define) for a given challenge by analyzing the user and customer as well as the business environment (2 - Needfinding). The third step, the synthesis, is abstracting information gathered during the first two phases in order to find more general and abstract concepts (3 - Synthesis). This is followed by three steps of problem solving in which ideas are generated (4 - Ideation), prototypes are built (5 - Prototyping) and tested (6 - Testing). As an underlying principle a Design Thinking team iterates through this process several times until it eventually can present a final prototype. The iteration cycles enforce rapid learning, encourage trial-and-error approaches and therefore push the creativity of the Design Thinking team. Alternation between divergent thinking and convergent thinking is an integral part of the described Design Thinking process.

The foundation of the ME310 approach are basic principles of “fail early and often”, iterate, experiment, create things, and be curious. Furthermore, the process view implements diverse methods that are performed repetitively in each single phase. As pointed out before, in each phase relevant

methods can be deployed tailored to the respective situation. For example, in the synthesis phase some teams might find it beneficial to apply user journeys whereas another team might use empathy maps to condense their field data (d.school 2013). According to Brenner et al. (2016), Design Thinking is generally implemented and seen in three different ways. First of all, Design Thinking is mostly interpreted as a mindset of humans in practice. Adopting the core principles of Design Thinking as a mindset, like “fail often and early” (Kelley and Kelley 2012), will lead to behavior in organizations that is described as Design Thinking. Second, Design Thinking can be considered a sequence of process steps turning it into a process for service innovation. Vetterli et al. (2016) delineate this process clearly and characterize the difficulties that arise when implemented in large organizations. Third, Design Thinking can be looked at as a collection of methods. From this perspective Design Thinking is made up of different methods which need to be arbitrarily combined with one another in order to achieve a creative outcome. In the beginnings of 2009, several books addressed Design Thinking (Brown 2009; Martin 2009). The main focus of all those authors was to describe the cultural and mindset aspects of Design Thinking. Beginning with Stickdorn and Schneider’s book (2012) on Service Design Thinking the Design Thinking literature became more specialized in regard to certain topics like Service Innovation or Business Model Innovation (Osterwalder and Pigneur 2010). The latest publications on Design Thinking provide practitioner catalogues of methods that can be used during the Design Thinking process (d.school 2013; IDEO.org 2015; Uebernickel et al. 2015). Going beyond the understanding of Brown (2008) or Kolko (2015), we explore the level of Design Thinking as a toolbox for methods in our study (Brenner et al. 2016).

Methodology

Over the last decade, Delphi studies have become a popular method for answering scientific questions in IS research. According to Paré et al. (2013), more than 42 studies with the objective to build consensus among experts addressing designated research questions were conducted until 2013. With regard to our research questions, we have selected the ranking-type Delphi for the following four reasons:

Deep knowledge: This study is an investigation on Design Thinking methods being used for service innovation which requires a broad and deep knowledge from proven experts who have successfully applied Design Thinking in real-life project settings. Thus, we believe a Delphi study is the most appropriate tool available to receive explicit response to our initial question.

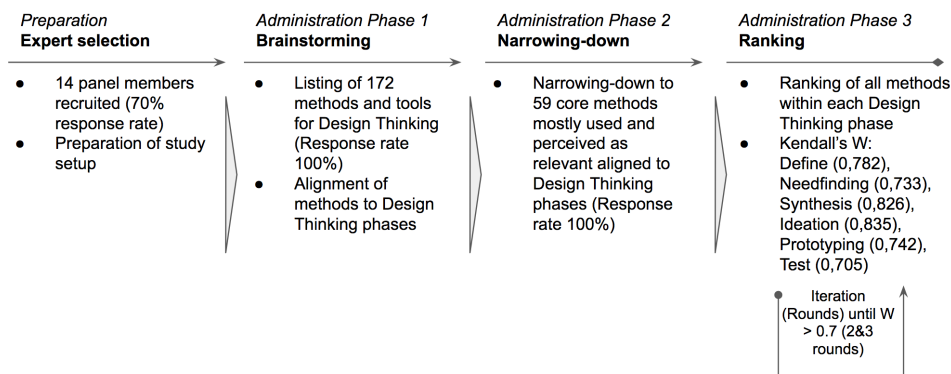
Number of experts: The application of Design Thinking methods for service innovation is still relatively new. Therefore, it is hard to find many experts in the field that are able to contribute with insights from different application fields. Among other methods, such as the nominal group technique, we judged Delphi to be the best method because of a small required sample size of 10 people (Okoli and Pawlowski 2004).

Richness: In comparison to traditional study formats, Delphi allows to collect richer data from participants through follow-up interviews and the possibility to set up workshops and telephone calls in between each round.

Collection of methods: Since we aimed at achieving a collection and evaluation of methods used in Design Thinking for service innovation, we deemed the ranking-type Delphi study the ideal option for this work (Paré et al. 2013).

Figure 1 shows our four-step process model. We adopted the common Delphi model from Schmidt et al. (2001) and enriched the quality of the process by considering newer studies from Rowe and Wright (2011) as well as Paré et al. (2013). The duration of the study (end-to-end) was around 1.5 months, which ranged in the common time frame of a Delphi study approach.

The standard Delphi process consists of the administration phases “Brainstorming”, “Narrowing-down” and “Ranking”. We added an initial phase Sampling or “Expert selection” as administrative steps to set up the entire study.

Delphi Study process**Figure 1. Delphi Study Process*****Preparation: Expert selection***

We applied high standards to select the study population by conducting the following steps (Okoli and Pawlowski (2004).

Definition of expert selection criteria

As pointed out by Paré et al. (2013), it is important to specify concrete and reliable criteria to select your sample. As a consequence, we decided to apply purposive sampling and specifically extreme sampling. The selection criteria for our population were three partite. First, all experts were required to have worked in the context of service innovation projects and applied Design Thinking methods for a considerable amount of time. Specifically, we looked for people who had a proven track record of conducting service innovation projects for the past three years. Second, the work experience of a potential participant had to match the focus of the present study. The population had to demonstrate through concrete project examples that they had been applying Design Thinking methods in practical setups. Third, we considered diversity in industries an important factor. Therefore, we aimed to convince experts from different industries like software, aviation, or utility.

Selection and invitation of experts as study population

We used a person-to-person cascade mechanism to gain access to experts in Europe (Rowe and Wright 2011). In a first step, we invited six people who we considered experts in the field, either directly from our immediate environment or via LinkedIn. We applied a careful review of publicly available information sources of the proposed study population and asked everyone to hand-in a resume in order to be in a better position to evaluate their expertise. Over an expected timeframe of two months we were using the person-to-person cascade mechanism, to address a population of twenty people in total, who qualified as our sample. The reported response rate was 70%, which resulted in a sample of 14 experts who participated in all rounds of our Delphi study and whose retention rate was thus 100% (Table 1). We followed Okoli and Pawlowski's (2004) recommendation and set up one panel group including all study participants. No obvious response bias in regard to our selection criteria was observed.

Experience level	Number	Participant profile
≥ 3 years	1	Industries: Telecommunication, Software, Manufacturing, Insurance, Professional Education, Pharmaceutical, Consulting, Aviation, Utility Job Profiles: Head of Design Thinking, Design Thinking Expert, Expert for human-centered design
≥ 5 years	5	
≥ 7 years	8	

Table 1. Participant Profiles

Data collection and analysis method

Our approach to data collection and analysis followed three administration phases (AP1 to AP3) (Okoli and Pawlowski 2004; Paré et al. 2013; Schmidt et al. 2001). To administer the process of data collection, we relied on Microsoft Excel (AP1) and Qualtrics (AP2 and AP3). The standard procedure included an email that was sent to the sample, including either the Excel file or an individualized link to the survey.

Administration Phase 1 (AP1): Brainstorming

To address the first research question (RQ1), we sent out the questionnaire to all survey respondents. Beforehand, we had prepared an email that explained how to fill out the spreadsheet and how to conduct the brainstorming. Our recommendations were to review the last projects and to recap the methods used during the projects first of all. In addition, we made clear that all methods known to them should be listed, even if they had not used them before. By giving this concrete instruction, we intended to increase the creativity and variety of the methods to be collected.

Furthermore, the experts were asked to give detailed explanations of those methods that might not be known very well. Since we had known all participants, we conducted callbacks in case of uncertainties in order to clarify the wording of the method and their description. In addition, we syndicated the entire list with known method catalogues that were created by practitioners (d.school 2013; IDEO.org 2015). The syndication added 11 methods that were not mentioned by the experts. As a result, we collected an amount of 172 methods in total (see Table 2).

Design Thinking Methods (172 items) (D=Define, N=Needfinding, S=Synthesis, I=Ideate, P=Prototype, T=Test; <u>underlined items</u> are considered highly relevant; *= no selection)			
2x2 Matrix	Customer Needs Matrix	<u>Low fidelity Tech Prototype [P]</u>	SCAMPER
3D Rapid Prototyping	<u>Dark Horse Prototype [P]</u>	Mapping against the Hype Curve	Scenarios
<u>5 Whys root cause analysis [N]</u>	<u>Day in the Life [N]</u>	Mapping S-Curves	Selection
6 Thinking Hats	<u>Desk Research [D]</u>	<u>Mindmap [D]</u>	Semantic Intuition
635 Method	Diary Studies	Miracle Question	Service Blueprinting
<u>Active Listening [N]</u>	Disney Method	<u>Mockups [P]</u>	<u>Shadowing [N]</u>
AEIOU-Framework	<u>Elevator Pitch [T]</u>	Moderated Blogs	<u>Sketches & Scribbles [P]</u>
Analog Worlds	<u>Empathy Map [N,S]</u>	<u>Moodboard [S]</u>	Social Network Mapping
Analogous Empathy	<u>Expert interviews [N]</u>	Mystery Shopping	Speed Dating
Ask your neighbor	<u>Extreme Users [N]</u>	NABC Pitch	Speed Geeking
Backcasting	<u>Feedback capture grid [T]</u>	Netnography	<u>Stakeholder Map [D]</u>
Behavioral Mapping	Flow Analysis	Object Storming	Stimulus Word Analysis*
Behavioral Prototype	<u>Focus Group [T]</u>	<u>Observation [N]</u>	<u>Storyboard [P]</u>
<u>Benchmarking [D,N]</u>	<u>Framing & Reframing [D]</u>	Open Hardware Platforms	<u>Storytelling [S]</u>
Bodystorming	Functional Analysis	Opportunity Area Formulation	Stretch the Goals
Bodystorming	Gameplan	Osborn Checklist	Superhero
Braindump	Gap Analysis	<u>Pain Gain Map [S]</u>	Survey
<u>Brainstorming [I]</u>	Get inspired by the Future	<u>Paper Prototype [P]</u>	SWOT
<u>Brainwriting [I]</u>	Graphic Recording	Participatory Design, Co-creation	Tag Cloud
<u>Business Model Canvas [P]</u>	Guided Tour	Pathfinders plotting*	Task Analysis
<u>Business Model Prototypes [P]</u>	Heaven & Hell	<u>Pattern Recognition [S]</u>	Test Camp
Camera Study	<u>High fidelity Tech Prototype [P]</u>	Pecha Kucha	Time Lapse Video
Card Sorting	<u>"How might we" Questions [I]</u>	Perfect Future Thinking	<u>Trend Research [D]</u>
CFB Method	<u>I like I wish [I,T]</u>	<u>Persona [N,S]</u>	Unboxing
Charetting	Idea Bundling	Personal Inventory/ Bag Check*	<u>Usability Testing [T]</u>
Check-In/ Check-Out	Idea City/ Idea Shopping	Photo Chain Analysis	User Centered Scenario Modelling
Circles of Influence	Idea Mixer	Photo Ethnography	User Eyes Theme Box
<u>Clustering [S]</u>	<u>Idea Napkin [I]</u>	Pitching	User Integration Prototyping
Collage	Ideal Final Result /TRIZ*	POEMS (Persons, Objects, Environment, Messages, Services)	User Map
Comics	Identifying Extremes and Mainstreams	<u>Point of View (Statement) [S]</u>	User Story Mapping
Community of Practice*	<u>Immersion [N]</u>	Porter's five forces	User Testing
Concept Extraction	Impose Constraints	Powers of Ten	Value Chain Analysis
Concept Scenario	<u>In the shoes of your customer [N]</u>	Prioritizing	Value Proposition Canvas
Consent Forms*	Insight Acting	Problem Reversal Technique	Video Prototyping
Consumer Clinics	<u>Insight Formulation [S]</u>	<u>Prototype for Empathy [P]</u>	Vision Statement / Visioning
Contextual Interviewing	Interview for Empathy	Pyramid of Purpose*	Visual Frameworks
Contextual Maps	<u>Interviewing [N]</u>	REICC (Reduce, Eliminate, Increase, Create, Combine)	<u>Warm up/ Energizer Tools [I]</u>
Cooking Study	Kano Model*	Remember the Future	Wayfinding
<u>Critical Function Prototype [P]</u>	<u>Lead User Method [N]</u>	Retrospective Meetings	Why How Laddering
Critical Reading Checklist	Learning from other brands	<u>Reverse Brainstorming [I]</u>	<u>Wireframe [P]</u>
Cultural Probe	<u>Lego Serious Play [P]</u>	Roadmapping	<u>Wizard of Oz Prototype [P]</u>
Customer Experience (Chain)	Live Prototyping	<u>Role Playing [P,T]</u>	Workalike
<u>Customer Journey [N,S]</u>	Looking from the Future	Sampling Techniques	World Café

Table 2. Brainstorming Phase: Design Thinking Methods

Administration Phase 2 (AP2): Narrowing-down

During the narrowing-down phase, we tried to condense our results to a more manageable list of methods to prepare the ranking phase (AP3). Following Schmidt et al. (2001), we presented a consolidated list of 172 items in random order to the study members. They were asked to select the most important methods with a maximum of 20 per Design Thinking phase without a lower limit. All experts together derived a comprehensive list of 59 methods. We had set an average percentage of majority opinions (APMO) cut-off rate of 30% per Design Thinking phase (von der Gracht 2012). As a result, the break-down of the Design Thinking phases looks as follows: Define (6), Needfinding (15), Synthesis (10), Ideate (7), Prototype (15), and Test (6) (quantities are overlapping, multiple assignments were explicitly allowed).

Administration Phase 3 (AP3): Ranking

Taking the adapted list of 59 Design Thinking methods, we sent out another questionnaire to the study participants. In the first round of phase 3, we asked them to rank the presented methods for each Design Thinking phase separately. The methods in each phase were listed in random order in all the ranking rounds of AP3. To measure the quality of the ranking we relied on a method for non-parametric rankings according to Schmidt et al. (2001). We chose the widely recognized Kendall's W coefficient of concordance. The W value ranges from 0 to 1. A 0 value indicates no agreement within the study participants. A value of 1 expresses full agreement with a given statement. Within the scientific community it is accepted that values of $W > 0,7$ represent high agreement. We repeated the rounds until we achieved the desired minimum W value of 0,7. In round 2 and 3, we presented the mean rank value per method and phase, as well as the anonymized expert feedbacks in text form. Except for the phase "Define" (W-value of 0,629 in round 2) we conducted two consecutive ranking rounds before the desired minimum W value was reached.

Results

As a result of this study, we have identified 59 Design Thinking methods out of a collection of 172 as particularly relevant for service innovation (Table 3). According to the procedures of a Delphi study, we had the participants rank the methods in several iterations. For most of the Design Thinking phases we had already achieved a satisfying Kendall W value above 0,7 after round 2. Thus, it can be concluded, that the experts highly agreed with the ranking of the importance of each method. The Define phase reached the same level of agreement after round 3 with a Kendall W of 0,782.

We split our results into two parts. First, we discuss the general findings in terms of looking at the entire Design Thinking method catalogue for service innovation. Second, we present the results of each Design Thinking phase in more detail and describe the top three ranked methods for each phase.

General findings

Based on expert opinions, we were able to brainstorm a comprehensive list of 172 methods that are known and used in Design Thinking projects for service innovation. In comparison to previously established method collections, this number of methods is by far more extensive and more multifaceted. Having conducted the subsequent AP2 step, we were able to distill 59 core methods for Design Thinking projects which can be used as a stable core for investigations like surveys or experiments in future Design Thinking studies. Only eight out of the 172 methods have not been categorized into any of the Design Thinking phases at all, which emphasizes the wide spread of different methods available and applied within Design Thinking for service innovation.

By looking at the results of Table 2 and 3, the study offers a new and deeper view on "how" service innovation can be achieved supported by Design Thinking methods.

Phase	Method name	Round 1*	Round 2*	Round 3*	Final Rank	Phase	Method name	Round 1*	Round 2*	Round 3*	Final Rank
DEFINE						IDEATION					
	Stakeholder Map	2,07	1,36	1,14	1		“How might we” Questions	1,86	1,07	-	1
	Desk Research	2,64	2	2,21	2		Brainstorming	1,93	2,14	-	2
	Framing & Reframing	3,57	3,71	3,29	3		Brainwriting	3,14	3,14	-	3
	Trend Research	3,93	4,29	3,93	4		Idea Napkin	4,36	4,36	-	4
	Mindmap	4,36	4,79	4,79	5		Reverse Brainstorming	5,14	5,29	-	5
	Benchmarking	4,43	4,86	5,64	6		Warm Up / Energizer Tools	5,57	5,36	-	6
							I like I wish	6	6,64	-	7
	<i>Kendall's W</i>	<i>0,261</i>	<i>0,629</i>	<i>0,782</i>	-		<i>Kendall's W</i>	<i>0,626</i>	<i>0,835</i>	-	-
NEEDFINDING						PROTOTYPING					
	Interviewing	1,93	1,71	-	1		Paper Prototype	2,43	1,29	-	1
	Observation	2,86	2,43	-	2		Role Playing (Experience Prototype)	5,64	4	-	2
	Active Listening	5,93	3,43	-	3		Sketches & Scribbles	5,86	4	-	3
	Expert interviews	5,86	4,71	-	4		Mockups	5,57	4,43	-	4
	Immersion	7,71	5,5	-	5		Critical Function Prototype	6,14	5	-	5
	Shadowing	8,36	7,14	-	6		Wireframe	6,36	6,43	-	6
	Customer Journey	8,29	7,57	-	7		Storyboard	6,43	6,71	-	7
	Extreme Users	8,57	8,29	-	8		Low fidelity Tech Prototype	7,14	7,71	-	8
	Persona	9,21	9,07	-	9		Dark Horse Prototype	7,86	8,5	-	9
	5 Whys root cause analysis	8,86	9,21	-	10		Wizard of Oz Prototype	8,86	9,86	-	10
	Day in the Life	9,14	11,14	-	11		Prototype for Empathy	10,79	11,07	-	11
	In the shoes of your customer	10,29	11,29	-	12		Business Model Canvas	11	11,79	-	12
	Empathy Map	10,57	11,79	-	13		Lego Serious Play	12,07	12,86	-	13
	Lead User Method	10,93	12,71	-	14		High fidelity Tech Prototype	11,64	12,93	-	14
	Benchmarking	11,50	14	-	15		Business Model Prototypes	12,21	13,43	-	15
	<i>Kendall's W</i>	<i>0,389</i>	<i>0,733</i>	-	-		<i>Kendall's W</i>	<i>0,434</i>	<i>0,742</i>	-	-
SYNTHESIS						TEST					
	Clustering	3,14	1,5	-	1		Feedback Capture Grid	1,93	1,36	-	1
	Storytelling	3,36	2,07	-	2		Usability Testing	2,79	2,07	-	2
	Insight Formulation	3,79	3,43	-	3		Role Playing	3,36	3,14	-	3
	Pattern Recognition	4,86	3,64	-	4		I like I wish	4,21	4,36	-	4
	Point of View (Statement)	5	5,79	-	5		Focus Group	4,21	4,79	-	5
	Persona	5,43	5,86	-	6		Elevator Pitch	4,5	5,29	-	6
	Customer Journey	6,21	7	-	7						
	Empathy Map	6,43	7,5	-	8						
	Pain Gain Map	8,07	8,79	-	9						
	Moodboard	8,71	9,43	-	10						
	<i>Kendall's W</i>	<i>0,389</i>	<i>0,826</i>	-	-		<i>Kendall's W</i>	<i>0,287</i>	<i>0,705</i>	-	-

Table 3: Ranking Overview of the most important Design Thinking Methods (* mean value)

Design Thinking phase-specific results*Define*

To achieve high agreement among the group of experts, we had to run three iterations until we reached a Kendall W of 0,782. This can be interpreted as a certain level of uncertainty and ambiguity in regard to the importance of Define methods. As Expert 8 stated: *“Considering all our comments; I can agree with the majority vote. We have individual preferences for certain methods; but I agree with the overall objective of the Design Thinking phase and how to guide and coach teams to define and explore the design space.”* Finally, the Stakeholder Map, Desk Research, and Framing & Reframing were chosen as the three most important methods for the Define phase. The Stakeholder Map method is recognized as a promising tool to deal with the complexity of actors in service ecosystems and to structure and visualize their relations with each other. Desk Research is thought to

be a valuable tool to gain a general understanding about the different dimensions of a problem statement and thus, to understand the multilayered nature of smart service applications. Finally, Framing & Reframing is used to iterate the overall focus of the service, especially in the fuzzy front end of service development when there are many uncertainties to tackle.

Rank	Method	Description	Literature
1	Stakeholder Map	• Analysis of all stakeholders that are affected by the design challenge • Stakeholders can be users and customers but other interest groups as well • The map depicts relationships between the groups incl. conflicts, information flows, etc.	Stickdom and Schneider 2012
2	Desk Research	• Desk research is known for collecting data based on literature and internet research • Outcomes provide Benchmarking, inspiration, market and technology overview	Uebersnickel et al. 2015
3	Framing & Reframing	• Framing and reframing is used to define the scope (and out of scope) of a project • Reframing techniques help to overcome mental barriers during the challenge definition. It takes user and customer feedback into consideration	d.school 2013

Table 4: The three top ranked Define methods

Needfinding

Patnaik and Becker (1999) frame Needfinding as an approach to collect and process qualitative field data to identify people's unmet needs. In regard to service innovation the experts of this Delphi study rated Interviewing, Observation, and Active Listening the highest within the group of selected needfinding methods (Table 5). We interpret these results that user activity flows and interactions with services require a deep understanding of the individual. Here, Interviewing and Observation act like antagonists. While Interviewing requires direct communication with the participant, Observation on the contrary puts the observer in a silent, "observing" position. According to SDL, value is always uniquely and phenomenologically determined by the beneficiary (Vargo and Lusch 2017). All three methods elicited in the study at hand go beyond traditional requirements engineering by focusing on the needs of the potential beneficiary of a service. Although finally ranked second, Expert 8 highlights the importance of Observation for needfinding by stating the following: *"Observation is the No 1 method I use for needfinding; before starting the interview process etc. The findings are always surprising and insightful and guide interviews and all techniques applied later in the needfinding phase."* Expert 13 puts this topic into perspective. *"Whether observation or Interviewing is first or second doesn't matter. So, I can agree here. Also, for most of the other items I'm ok with the average option."*

Rank	Method	Description	Literature
1	Interviewing	• Conversation between two or more people where questions are asked by the interviewer • Elicitation of facts or statements from the interviewee	d.school 2013; Myers 1997
2	Observation	• Observation and descriptions of happenings in the real world • Observer is trying not to influence the observed setting	Myers 1997
3	Active Listening	• Technique to elicit needs by understanding and responding to what someone has said • It is widely used to gain a deep understanding of a topic	Uebersnickel et al. 2015

Table 5: The three top ranked Needfinding methods

Synthesis

For the synthesis phase, Clustering, Storytelling, and Insight Formulation were rated highest by the experts (Table 6). As described in some practitioner guidelines for Design Thinking (e.g. Meyer-Hoellings et al. 2016), our findings confirm the often-mentioned analytical process of communicating and sharing data within the team, to structure the data, and finally, condense the data to concrete insights about the given problem. Overall, the experts concurred on the sense making process of the collected data from needfinding to opportunity areas and insights as a more generic, chronological sequence of steps that need to be undertaken. Expert 12 emphasizes this point by stating: *"For myself, I have put the points into a logical order. As there is no teamwork without storytelling; no insights-formulation etc. is possible without clustering; these points are most important to me"* (translated).

Rank	Method	Description	Literature
1	Clustering	• Technique to bundle ideas into cluster / buckets • Each cluster represents logical topics for the group • Clusters can have interdependencies	IDEO.org 2015
2	Storytelling	• Method for exchanging knowledge collected during needfinding • Based on active listening and telling each participant stories	Meyer-Hoellings et al. 2016
3	Insight Formulation	• Processes to distill and capture the most important learnings from needfinding • Each learning is usually represented by an insight	Meyer-Hoellings et al. 2016

Table 6: The three top ranked Synthesis methods*Ideation*

The three top rated methods within the ideation phase are "How might we" Questions, Brainstorming, and Brainwriting (Table 7). Of particular note are "How might we" Questions as most experts agree that a clearly defined question is necessary to be successful in finding new and creative ideas which is also supported by Berger (2012). Expert 7 states that in some situations Brainwriting might be more effective than Brainstorming: *"In my experience, "Brainwriting" is more effective than "Brainstorming", which is why I rated it as more important."* Some dispute for the prioritization of Warm-up games and exercises was recognized within the group of experts as some considered them an essential part in the ideation phase and others clearly did not. Finally, most experts agreed with Expert 12: *"For me the "How might we" Questions are essential for a good brainstorming and therefore elementary. Warm up: Yes; but for me it is something that can be neglected"* (translated).

Rank	Method	Description	Literature
1	"How might we" Questions	• Way of asking questions to initiate/ignite ideation sessions • "How might we ..." is often used for Brainstorming but also to initiate entire projects	Berger 2012
2	Brainstorming	• Brainstorming is a group creativity technique • Can be run in different ways - mostly used is Osborn's method	d.school 2013; Osborn 1963
3	Brainwriting	• Similar technique to Brainstorming but all ideas are collected in written format before the information exchange within the group starts	Uebornickel et al. 2015

Table 7: The three top ranked Ideate methods*Prototyping*

Of particular interest of this study is the prototyping phase. The experts rated "Paper prototyping" (see Table 8) as the most important and the most relevant technique for service innovations. This fact might come as a surprise because of the intangible nature of services, but after addressing the topic for clarification the experts were determined that even services can be prototyped with paper. Expert 5 expressed his opinion clearly in the following statement: *"In our design projects, sketches and scribbles are always the first step. They guide the other prototyping phases. We also tend to work towards a Wizard of Oz prototype faster than indicated in the ranking - e.g. why should I invest time into a low-fi tech prototype, if I can just as well "fake" the technical functionality in a Wizard of Oz."* The selection of "Role playing" as an important method for service innovations is rather obvious, since services focus on the interaction of users with software applications for example. A role play provides a valid tool to create the intended experience of a service in a quick and easy fashion.

Rank	Method	Description	Literature
1	Paper Prototype	• Tangible representation of a service to facilitate testing • Paper prototypes are of low fidelity and used to quickly express ideas in early phases	Uebornickel et al. 2015
2	Role Playing	• Role playing is used to act out service scenarios quickly and simply	IDEO.org 2015
3	Sketches / Scribbles	• Sketching and Scribbling is all about drawing ideas and making them more tangible.	IDEO.org 2015

Table 8: The three top ranked Prototype methods

Testing

Testing includes the Feedback Capture Grid, Usability Testing, and Role playing. The first method is traditionally used to gather and collect feedback in a structured form from testers in Design Thinking projects. The second method is seen as a tool to quickly verify not only the use of a service, but also its usability aspects. Some experts justified this priority ranking with the interlinking nature of the use and usability of services. Therefore, they prefer to quickly test the use and usability component. Role playing, also used as a prototyping method, was ranked third due to the immateriality of (digital) services. In this regard, role playing can be applied to create an audible and visible experience of a concrete service for users or customers during testing. Therefore, it enhances the testing procedure according to some experts, especially in testing services and processes.

Rank	Method	Description	Literature
1	Feedback Capture Grid	- Simple framework to capture user, customer or stakeholder feedback while testing - Dimensions: Likes, Wishes, Ideas, Deltas	Uebernicket et al. 2015
2	Usability Testing	- Aims to test the usability of a service - Target groups are typically users and customers	Uebernicket et al. 2015
3	Role Playing	Role playing tests the interaction and experience provided by a prototype	IDEO.org 2015

Table 9: The three top ranked Testing methods

Discussion, Implications, and Limitations

This study was motivated by a poor understanding of how Design Thinking methods contribute to service innovation in the digital age. In order to enhance the understanding of this question, we conducted a Delphi study to identify the most important Design Thinking methods for service innovation. Our study yielded the identification of the 52 most relevant methods, ranked by importance according to the six phases of the Design Thinking process model (see Table 3). We see three major theoretical implications of this study.

First, the relevance of Design Thinking is recognized in existing literature on service innovation, where it is often understood as a certain mindset encouraging empathy for different perspectives of end-users, their experiences, and problems (Barrett et al. 2015; Lusch and Nambisan 2015). Despite the validity of understanding Design Thinking as a mindset, understanding Design Thinking as a specific set of methods is neglected in current service innovation research. The findings obtained in our study extend the knowledge of Design Thinking and provide better knowledge about the importance of Design Thinking methods for service innovation. Particularly with the advent of smart service systems, an understanding of Design Thinking as a set of methods serves as a relevant perspective to advance theory on (smart) service design and service systems engineering (Böhmman et al. 2014; Maglio 2015; Stickdorn and Schneider 2012).

Second, the results of our study can be interpreted in the light of the different stages of digital innovation from Fichman et al. (2014), which consists of the following four stages: (1) Discovery: combining activities to discover and explore new possibilities for service innovations, (2) Development: the results derived from the first phase are being transformed into “usable” innovations, (3) Diffusion: deployment of the service and expansion to a broader within the user or customer base, and (4) Impact: appropriation of value. Design Thinking addresses the first stage of the process model: It targets exploring and validating new possibilities for service innovations in a digital world based on a structured process. Therefore, Design Thinking provides concrete methods that can be used to develop a concrete service in stage two. In this context, we also want to point out the method Service Blueprinting, which is the visualization of all touchpoints and processes aligned to the user experience above and below the line of visibility to the user (Biege et al. 2012; Bitner et al. 2008). Being part of the original method collection, some experts in our study nominated Service Blueprinting as an important method for several phases of the Design Thinking process (Define, Synthesis, Ideation, and Prototyping). However, they, eventually, did not consider it one of the most important methods in Design Thinking for service innovation. We confirmed this evaluation with some experts, who explained their decision by pointing out their perception on the main benefit of

Service Blueprinting in later stages of the innovation process, whereas Design Thinking is mainly applied before this detailed specification to tackle wicked problems in the discovery phase or fuzzy front end of the service innovation process.

Third, the present study implies that the context of service innovation is a promising area for further research on the actual usage of Design Thinking. In the digital age, desirability becomes an increasingly important aspect of the design of digital offerings and smart services (Yoo 2017). In that vein, we see service innovation as a more matured research topic that can provide proven tools and methods to advance the conceptualization of Design Thinking. Since the examination of human-focused approaches for service innovation is still ongoing, researchers should investigate service innovation concepts for the context of Design Thinking in order to identify new developments.

In addition to the theoretical contributions, the results of our Delphi study present valuable insights for practitioners. We believe, that an in-depth comprehension of Design Thinking methods helps to bridge the gap between existing corporate business processes for service innovation and the Design Thinking process (Kupp et al. 2017). The list of most relevant Design Thinking methods validated by 14 experts clearly depicts a set of methods that should be taken into consideration when approaching service-driven problem statements with Design Thinking. Furthermore, the ranking provides a compact list containing the most important methods according to each Design Thinking phase. Project managers can use the list to steer their limited resources toward applying the most relevant methods. Beginners in the field of Design Thinking and service innovation might use it as a guide to start with the most important ones.

When we set up our study, we tried to be as diligent as possible. Nevertheless, we are aware that this study has some limitations in terms of generalizability and expert selection that need to be considered for further research. First, the study focuses on the European context of Design Thinking. The results are based on the participation of 14 experts who were not chosen randomly and thus, may not be generalizable to a larger population. Second, we applied the specific Design Thinking process model of the Stanford University, but, as already indicated in the research background, many interpretations of Design Thinking exist. Insofar it would be valuable to extend the scope of this research to other parts of the world, providing a larger, randomized sample, and to examine further Design Thinking interpretations, too. We would like to encourage other researchers to validate our study results. To generate further insights, future research might be inspired to leverage our findings as a research agenda for investigating Design Thinking methods on a more granular level, matching them with existing service innovation process models.

Despite the limitations of our research, to the best of our knowledge, this is the first study that leverages a comprehensive set of experts from different industries and multiple organizational sizes to identify the most important Design Thinking methods for service innovation. We believe that this is a first step towards a profound understanding of leveraging Design Thinking methods in service innovation and a robust foundation for further scientific studies.

Conclusion

This work sheds some light on the use of the most relevant Design Thinking methods for the design of service innovation. To answer our research questions, we have conducted a Delphi study on experts' opinions. We identified 52 Design Thinking methods and ranked their importance allocated to the phases of a Design Thinking process model. The contributions of our findings are beneficial in three respects. First, this study identifies concrete Design Thinking methods highly suitable for service innovation. Second, the list of methods assigned to specific Design Thinking phases provides a foundational understanding on how Design Thinking can be leveraged for service innovation. Third, we contribute to practice as we provide a comprehensive format of the most important methods which allows for a more structured usage of those. We believe that the results of the study provide a solid foundation for many following research projects because they give a better understanding of “*what*” Design Thinking represents in the context of service innovation and “*how*” service innovations can be achieved by applying Design Thinking.

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