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The role of service design in designing and developing AI applications: scoping review

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Designing AI products presents novel challenges that traditional design methods may be insufficient to tackle. With a growing shift from design of "products" to "services", service design is a promising approach to facing these new and unique challenges. However, little research has been done to understand how service design may contribute, or to identify how it might have been adopted and used in existing projects where AI solutions were designed. This research performed a scoping review on extant publications that highlighted two things: challenges faced by designers that perceived a role of service design, and how service design has been adopted in existing AI products design processes. The review findings revealed how service design can foster new collaborations, and how service blueprints and journey maps are being used in existing AI projects. We discuss future design and research opportunities for designers to utilize service design in designing AI applications.

Keywords: service design; artificial intelligence; machine learning; scoping review

1 Introduction

The application of human-centered design to building AI applications and products has become a steadily growing field of interest for researchers, designers, and practitioners alike (Dove et al., 2017; Holmquist, 2017). However, designing AI systems comes with its own set of unique challenges that may not be typically addressed by traditional user experience (UX) or human-computer interaction (HCI) methods and as such, there are calls for design researchers and practitioners to rethink the current methods, tools, and approaches to designing smart and intelligent AI agents. (Chromic et al., 2020; Dove et al., 2017; Hartikainen et al., 2022; Winter & Jackson, 2020; Yang, 2019).

In particular, service design has emerged as a promising approach for designing AI products (Forlizzi, 2010, 2018; Zimmerman & Forlizzi, 2013). Though the fields of service design, UX design, and human-centered design are often considered similar and overlap (Lee et al., 2022), service design provides its own unique benefits to the field and practice of design. Concepts, tools, and methods from service design, such as networks of multiple actors in various roles, value co-creation or service blueprints (Forlizzi, 2018; Wild, 2008; Zimmerman & Forlizzi, 2013), are increasingly adopted and used alongside

existing UX and design frameworks. Furthermore, there has been a shift in mindset from designing "products" to designing "services" as AI becomes more accessible and will eventually become a service (Holmquist, 2017).

Existing research on the challenges faced when designing and/or developing AI applications seem to propose solutions that perceive and suggest a potential involvement of service design capabilities. For example, multiple studies (e.g., Girardin & Latha, 2017; Hartikainen et al., 2022; Kayacik et al., 2019; Subramonyam et al., 2023; Yang et al., 2018) proposed a greater need for collaboration within cross-functional teams consisting of varied roles including designers, data scientists, and engineers. Studying the nature of these novel collaborations falls under the service design capability (Forlizzi, 2018; Lee et al., 2022).

However, academic research that systematically examines how service design may contribute to designing and developing AI applications has been scarce. Responding to this gap, this study aims to have an understanding of what potentials of service design have been recognized and adopted for the design and development of AI applications so far. We adopted a scoping review (Levac et al., 2010) to identify a set of existing literature that address opportunities from service design in building AI applications. From the final 28 papers, we examine what service design capabilities have been adopted for AI development and what would be future opportunities. The study aims to explore two main research questions:

- Research question 1: What are the current limitations/challenges/gaps of designing for AI applications that perceive the role of Service Design?
- Research question 2: How has Service Design been adopted and used in developing/delivering AI solutions?

2 Method: scoping review

The scoping review (Levac et al., 2010) was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher et al., 2009). We used SCOPUS as a main data source. We searched for a combination of the terms "Service Design" and "Artificial Intelligence" appearing in the title, abstract, or author keyword of papers. Recognizing the interchangeable uses of the terms, we also searched for "Experience Design" or "Human Centered Design" in replacement of "Service Design", and "Machine Learning" or "ML" or "AI" in replacement of "Artificial Intelligence".

507 documents were screened to identity publications that were relevant to the purpose of our study. As results of the title, abstract, and keywords review and the full-text review according to the inclusion and exclusion criteria, 17 papers were identified (Figure 1). Through forward backward searches, 11 additional papers were added. As results, a total of 28 papers were identified for the final analysis. Out of the 28 papers, 21 papers met inclusion criteria #1, which discussed the current challenges of designing AI applications that service design could be adopted for. The remaining 7 papers met inclusion criteria #2, which focused on the studies that have already involved service design capabilities when designing AI applications.

To account for inter-rater effects in our screening process, the first author screened the full text of 70 papers, and the second author randomly screened 20 per cent of the same papers using the same

screening criteria. The first and second authors then had a session to resolve discrepancies, and repeated the screening process until the inter-rater reliability, Cohen's unweighted kappa, was above 0.6.

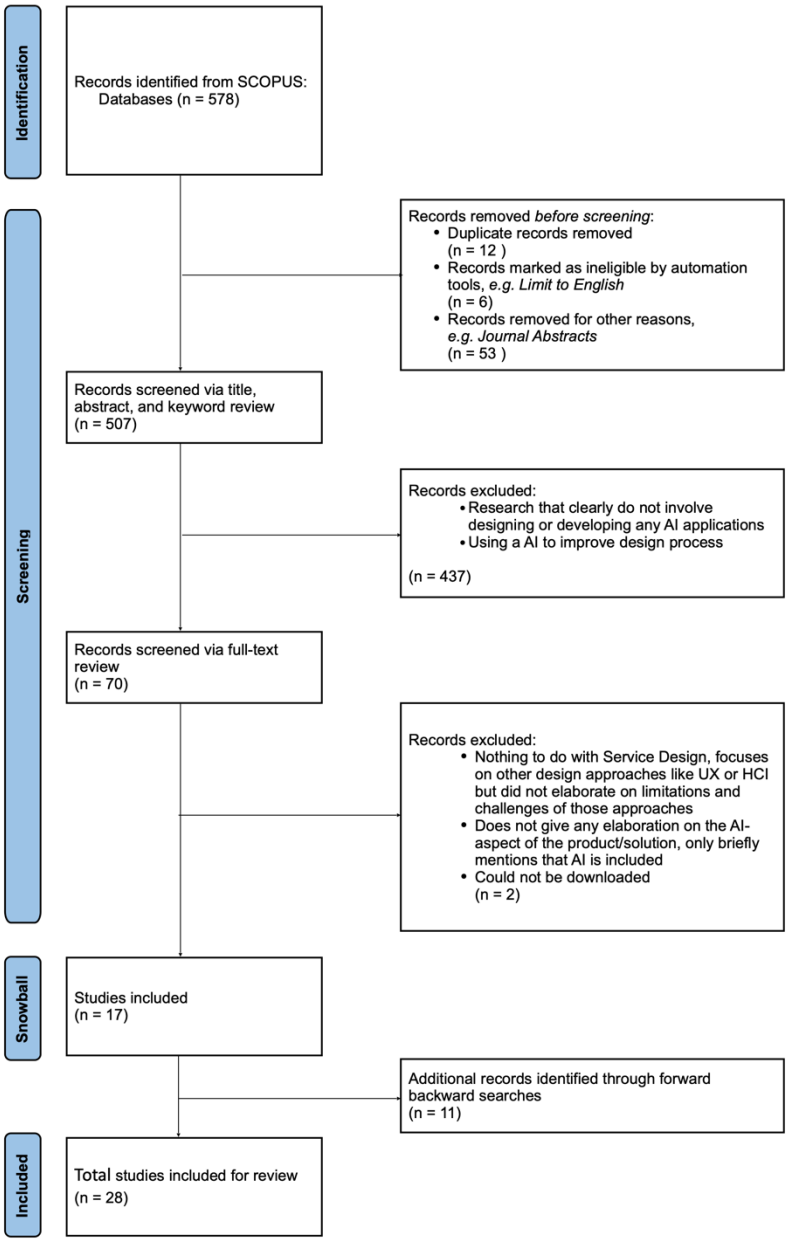

Figure 1. Screening process and criteria.

An inductive content analysis (Elo & Kyngäs, 2008) was used to find recurring patterns and themes responding to RQ 1 and RQ 2. As results, five themes on challenges that perceive the roles of service design were identified for RQ 1, and the other five themes on service design capabilities that have been adopted were identified for RQ 2.

3 Results

We present the results of our analyses under two sections, addressing each research question.

3.1 Challenges that perceive the roles of Service Design

Out of 21 papers that perceived possible roles of service design for the design and development of AI applications, *multiple stakeholder collaboration* required for AI applications development was addressed as a challenge the most often, followed by *lack of knowledge* and *uncertainty of AI* (see Table 1). In the subsequent sections, we will unpack our findings for each type of challenge.

Table 1. Challenges that perceive the role of Service Design

Challenges	**Service Design Capabilities Proposed**	**Number of papers (%)**
Challenge #1: Collaboration Collaboration needs to be improved between designers and different stakeholders including but not limited to: Engineers Data Scientists Domain Experts Users	Collaborative Network involving multiple roles Value co-creation/ exchange Backstage work process	16 (76.2%)
Challenge #2: Lack of knowledge Designers need to increase their understanding of technical knowledge like Machine Learning concepts, and data literacy	Collaborative Network involving multiple roles Value co-creation/ exchange	12 (57.1%)
Challenge #3: Uncertainty of AI Designers need to consider designing experiences that evolve over time, as the AI models continuously learn and adapt in different contexts.	Journey Perspective	10 (47.6%)
Challenge #4: Considering multiple touch points Designers need to take multiple touch points into consideration when designing AI applications	Backstage work process Multiple touch points Journey Perspective	4 (19.0%)
Challenge #5: Designing for multiple groups of users Designers need to take multiple groups of users into consideration when designing AI applications	Collaborative Network involving multiple roles Journey Perspective	2 (9.5%)

1.1.1. Challenges related to multiple stakeholder collaboration

From the analysis of the papers, one of the most significant challenges brought up was the burgeoning importance of collaborations that designers needed to foster with different stakeholders. 15 papers reported that designers should work closely with developers, data scientists, and other technical roles to co-create AI applications (Girardin & Lathia, 2017; Kayacik, 2019; Subramonyam et al., 2021; Zhang

et al., 2019). Zhou et al. (2020) addressed in their paper that this nature of co-creation and value exchange may be facilitated by service design tools, frameworks, and concepts, as service design addresses engagement between different stakeholders.

Similarly, Heier et al. (2020) argued that developers, data scientists, and even upper management stakeholders need to be aware of the importance of designers in the AI development process. This requires them to learn the backstage work process of designers, and the focus on backstage work processes is an aspect that service design can help with.

Four papers reported on the collaboration between designers and clients brought about by the nature of the AI design and development process. Clients are expected to participate throughout the process with involvement in various phases (Bergström & Wärnestål, 2022; Hartikainen et al., 2022; Holmquist, 2017; Van Allen, 2018). Moreover, designers have a responsibility to educate the client in the capabilities of AI, because they set the end user requirements and make major decisions for the product (Hartikainen, 2020). Service design tools and frameworks may also contribute to fostering this collaboration, as it involves the exchange of values between multiple groups of stakeholders.

3.1.1 Challenges related to lack of technical knowledge

12 papers reported on this challenge that highlighted the necessity for designers to gain knowledge and understanding of machine learning concepts as well as data literacy. One way of doing so was for designers to work closely with engineers and data scientists by "immersing" themselves in these technical teams for an extended period of time. Designers would gain machine learning knowledge from developers, and developers would in turn, gain an understanding of design principles and the importance of user-centered thinking (Kayacik, 2019). The nature of this collaboration reflects service design capabilities of a collaborative network involving multiple roles, and how they exchange value.

Designers also need to gain a better understanding of how the AI works behind the scenes, as designing for AI applications and products extends beyond the interface and into the design of AI components e.g., behavior (Subramonyam, 2021). This challenge proposes the service design capability of considering backstage work processes as designers should consider the backstage process of how the AI works.

3.1.2 Challenges related to the uncertainty of AI

Ten papers reported on challenges related to the uncertainty of AI. Due to the evolving nature of AI models as they learn from data and change their outputs accordingly, designers need to start considering the user journey holistically to account for the potential experiences that users may undergo. This includes the user journey after the launch of a product, as the AI/ML models will continue to learn and evolve, and this will implicate the AI application's design (Girardin & Lathia, 2017; Wu & Zhang, 2020; Zdanowska & Taylor, 2022). While existing design processes typically end at the delivery of the designed outcomes, service design considers value-in-use (Arvola & Holmlid, 2016) after the delivery and the launch of services.

3.1.3 Challenges of considering multiple touch points and multiple user groups

This subsection presents the last two themes. In four studies, there were findings that suggest that "existing HCI design techniques such as prototyping and simulating complexity of enterprise ML systems are insufficient" (Zdanowska & Taylor, 2022). They were "interface focused" and "not suited to designing how things work behind the scenes" (Zdanowska & Taylor, 2022). For example when

designing chatbots, the user experience is not bound to the interface, but more so the content in the interaction. This focus on “how things work behind the scenes” (Zdanowska & Taylor, 2022) is addressed by service design as the backstage processes of services are essential design scopes in service design.

AI applications may also be multimodal and consist of non-visual interactions which designers need to account for (Van Allen, 2018). Another challenge includes things like ML and AI-based systems having complex systems that learn and evolve over time, which poses a challenge for designing interactions between these systems and their users (Wu & Zhang, 2020). These interactions are often non-visual and multimodal, requiring designers to consider new "design materials," such as invisible algorithms. (Van Allen, 2018). This consideration of how to design multimodal interactions correspond to service design capabilities of “multiple touch points”.

Two papers reported on how AI-powered interactions can adapt to different users so the AI application may be used by a wider user population. Designers thus should learn how to design one application for multiple different groups of users. (Dove et al., 2017; Hartikainen et al., 2022). This includes considering the workflows and actions of varying user types and personas. Accounting for how different groups of users interact within an AI application or product proposes the service design capability of collaborative networks involving multiple roles, and considering the journey perspective of each group of users.

3.2 Adoption of service design capabilities

Table 2. Adopted capabilities of service design

Capabilities of Service Design	Examples of how it was adopted	Number of papers (%)
Collaborative Network Involving Multiple Roles	“To consider how an implant decision was reached across many clinicians roles and contexts” (Yang et al., 2016) “Authors co-created with these senior users to engage them in the design process of AI-enabled mobility service" (Li & Lu, 2021)	5 (83.3%)
Journey Perspective	Created a patient journey map (He et al., 2021)	5 (83.3%)
Multiple Touch Points	Mapped out touch points like Smart device, Space, Ambience in Service Blueprint (Li & Lu, 2021)	4 (57.1%)
Backstage Work Process	Used a framework called Smart Service Blueprint Design to design a reservation platform with AI (Li & Lu, 2021)	2 (28.6%)
Value Exchange/ Co-creation	Authors co-designed, developed, and evaluated intelligent decision support system with therapists (Lee et al., 2020)	1 (14.2%)

Of the 7 papers that have adopted service design for AI applications design/development, the service capabilities that were adopted the most were collaborative network involving multiple roles and journey perspectives (see Table 2).

3.2.1 Collaborative network involving multiple roles

Five papers adopted service design approaches to consider how various groups of users and stakeholders interacted within an AI application (Lee et al., 2020; Li & Lu, 2021; Ghunaim et al., 2022; Vetch et al., 2021; Yang et al., 2016). For example, Yang et al. (2016) mapped out how implant decisions were reached across many clinicians' roles and contexts. Similarly, Li and Lu (2021) created a service blueprint to map out how senior users, student drivers, and elderly center managers formed a collaborative network within an AI reservation platform. In the same study, designers also co-created with senior end-users by engaging them in the design process of AI-enabled mobility service.

3.2.2 Journey perspective and orchestration of multiple touch points

The journey perspective of users was considered in two studies where a patient journey map was created, and in another where students' telehealth experience was charted onto a journey map (Ghunaim et al., 2022; He et al., 2021; Yang et al., 2016). This gave designers a more holistic understanding of the entire workflow of users.

Designing for multiple touch points was shown in the journey map in one study where the user's journey in different channels of the telehealth app like the website, clinic, and telehealth visit, was considered (Ghunaim et al., 2022). This is another capability of service design that helps designers take into account the different possible modes and ways in which a user can experience the AI product, and not just on one mere interface. This is shown again in the study by He et al., (2021) where designers identified three touchpoint needs and proposed three corresponding touch points of the AI solution.

3.2.3 Backstage work process and value co-creation

We found two studies where the backstage work process of employees was considered within the service blueprint of a student mobility service (Ghunail et al., 2022; Li & Lu, 2021). This was useful to designers as it helped them understand the level of involvement and complexity of the backstage actors, and possible design opportunities for embedding AI technology.

From our search, only 1 paper by Li & Lu (2021) covered the aspect of value co-creation by designers engaging senior end users who were non-technical, in the design process of AI-enabled smart mobility service (Li & Lu, 2021). This is a form of value co-creation and is a Service Design capability.

4 Discussion

There is a notable potential for service design to contribute significantly to the design process of AI applications, and the results of this study have highlighted such opportunities of service design for AI applications. Firstly, designers can utilize service design by addressing new collaborative networks between different stakeholders that are enabled by AI products/services. Our findings show that there are several distinct types of collaborative networks – one focusing on how designers interact with their technical teammates that they work with to build the AI application, one on interacting with users, and one on designing for interactions between different groups of users of the AI application. Service design can clarify these networks and facilitate their collaborations through its co-creative processes and tools and visualizations of complex networks and value relationships.

The collaborative network formed by designers interacting with technical teammates, is a finding that has been widely reported on, but the actual ways of collaborations have not been closed studied or

researched on. In the seven papers we found that utilized service design capabilities in designing AI applications, none focused on how designers collaborated with engineers, data scientists, or other technical roles in the team to design and develop the application. The closest study is perhaps Google's PAIR Bungee program where a UX researcher, interaction designer, and prototyper, were placed in a "ML host team" for three months, with the goal of learning from each other and exchanging valuable skills and insights of each respective domain knowledge (Kayacik, 2019). However, this is still just a research program and it may or may not necessarily reflect the actual workings of the team if they were to actually design and develop a real AI product or application together.

Another finding from our review sheds new light on the value of using service design in designing for AI applications to consider multiple touch points and multiple groups of users. In the context of AI applications, this is particularly important as AI applications are often multi-modal and can adapt to serve different needs of different groups of users. Current UX and HCI frameworks focus more on single interfaces and often focuses on a single user journey. This reinforces the notion from existing research that service design has a more holistic approach (Lee et al., 2022), and this is indeed helpful for tackling the new challenges brought about by AI and machine learning.

While the potentials of service design to deal with challenges from designing AI applications are gaining tractions, the number of studies that have actually utilized and reported results of adopting service design in the process is still small (seven papers in our study), and most of them do not explicitly adopt and credit service design, but do so in indirect ways by using service design tools, frameworks, or concepts. Our analysis reveals that service design tools like service blueprints and user journey maps have been most useful in helping designers understand how AI can fit into the existing workflows and journeys of different groups of users.

Beyond the backstage process and user journey, our analysis responding to the first research question highlighted the potential of service design for multiple stakeholder collaborations and knowledge co-creation. Future studies may aim to benefit from adoptions of service design notions on value co-creation and co-creative approaches, throughout the pre, during and post development phases. Co-creative approaches of service design could be more utilized to deal with varying knowledge levels of AI among multiple stakeholders. In addition, the notions of service co-production in use contexts and value in-use (Zeithaml et al., 2006) will be useful to deal with the unpredictability of AI system behaviors and users' interactions with AI systems. As AI applications are increasingly considered as services, instead of products (Holmquist, 2017; Javadi et al., 2020), we expect that there would be more interests in service design for AI applications development and design. Thus a systematic understanding between AI development challenges and service design capabilities will greatly contribute to this emerging demand. Based on the findings from this scoping review, empirical studies, for example, in forms of case study or design projects, should be conducted in the future to verify various benefits of applying service design for the development AI applications and to develop dedicated frameworks and methods.

5 Conclusion

In this paper, we conducted a scoping review to identify ways in which the challenges in the process of building AI applications perceive the role of service design. This resulted in identifying five types of service design capabilities, including Collaborative network involving multiple roles, value co-creation/

exchange, backstage work process, journey perspective, and multiple touch points. We also examined how service design capabilities have been used in existing real-world projects, and found that a collaborative network involving multiple roles and considering journey perspectives in the design process were the most common capabilities of service design that was utilized in the building AI applications.

The burgeoning importance of service design in creating AI applications is a new and understudied area of research, and this work examines the essential application of service design capabilities and future opportunities. Through this work, we hope to offer points of reference for design practitioners, researchers and other stakeholders for the development of AI applications and contribute to shape new service design areas.

References

Arvola, M. & Holmlid, S. (2016). Service design ways to value-in-use, Proceedings of the ServDes.2016 Conference. Nicola Morelli, Amalia de Götzen and Francesco Grani (eds), 2016, pp. 530-536.

Bergström, E., & Wärnestål, P. (2022). Exploring the Design Context of AI-Powered Services: A Qualitative Investigation of Designers' Experiences with Machine Learning. *Artificial Intelligence in HCI*, 3–21. https://doi.org/10.1007/978-3-031-05643-7_1

Dove, G., Halskov, K., Forlizzi, J., & Zimmerman, J. (2017). UX Design Innovation. *Human Factors in Computing Systems.* https://doi.org/10.1145/3025453.3025739

Fabien Girardin and Neal Lathia. When user experience designers partner with data scientists. In *The AAAI Spring Symposium Series Technical Report: Designing the User Experience of Machine Learning Systems*. The AAAI Press, Palo Alto, California, 2017. ISBN 978-1-57735-754- 4. URL https://www.aaai.org/ocs/index.php/SSS/SSS17/paper/view/ 15364. 3, 2.2.1, 2.2.1, 5, 3.2.2, 6.3.1, 6.3.2, 7

Forlizzi, J. (2010). All look the same? A comparison of experience design and service design. *Interactions, 17*(5), 60-62. https://doi.org/10.1145/1836216.1836232

Forlizzi, J. (2018) Moving beyond user-centered design. *Interactions, 25*(5), 22-23. https://doi.org/10.1145/3239558

Ghunaim, H., Weekes, T. R., & Eskridge, T. C. (2022). Designing an AI Assistant for Student Telehealth: A Case Study Using Human-Centered Design. 2022 IEEE 3rd International Conference on Human-Machine Systems (ICHMS). https://doi.org/10.1109/ichms56717.2022.9980800

Hartikainen, M., Väänänen, K., Lehtiö, A., Ala-Luopa, S., & Olsson, T. (2022). Human-Centered AI Design in Reality: A Study of Developer Companies' Practices. Nordic Human-Computer Interaction Conference. https://doi.org/10.1145/3546155.3546677

He, Q., Du, F., & Simonse, L. W. (2021). A Patient Journey Map to Improve the Home Isolation Experience of Persons With Mild COVID-19: Design Research for Service Touchpoints of Artificial Intelligence in eHealth. *JMIR Medical Informatics, 9*(4), e23238. https://doi.org/10.2196/23238

Heier, J., Willmann, J., & Wendland, K. (2020). Design Intelligence - Pitfalls and Challenges When Designing AI Algorithms in B2B Factory Automation. *Lecture Notes in Computer Science*. https://doi.org/10.1007/978-3-030-50334-5_19

Holmquist, L. E. (2017). Intelligence on tap. *Interactions, 24*(4), 28–33. https://doi.org/10.1145/3085571

Javadi, S. A., Cloete, R., Cobbe, J., Lee, M., & Singh, J. (2020). Monitoring Misuse for Accountable "Artificial Intelligence as a Service." https://doi.org/10.1145/3375627.3375873

Kayacik, C., Chen, S., Noerly, S., Holbrook, J. S., Roberts, A., & Eck, D. (2019). Identifying the Intersections. *Human Factors in Computing Systems*. https://doi.org/10.1145/3290607.3299059

Lee, J. P., Yap, C., & Roto, V. (2022). How HCI Adopts Service Design. In CHI Conference on Human Factors in Computing Systems. https://doi.org/10.1145/3491102.3502128

Lee, M. G., Siewiorek, D. P., Smailagic, A., Bernardino, A., & Badia, S. B. I. (2020). Co-Design and Evaluation of an Intelligent Decision Support System for Stroke Rehabilitation Assessment. Proceedings of the ACM on Human-Computer Interaction, 4(CSCW2), 1–27. https://doi.org/10.1145/3415227

Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: advancing the methodology. *Implementation Science, 5*(1). https://doi.org/10.1186/1748-5908-5-69

Li, F., & Lu, Y. (2021). ENGAGING END USERS IN AN AI-ENABLED SMART SERVICE DESIGN - THE APPLICATION OF THE SMART SERVICE BLUEPRINT SCAPE (SSBS) FRAMEWORK. *Proceedings of the Design Society, 1*, 1363–1372. https://doi.org/10.1017/pds.2021.136

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *PLOS Medicine, 6*(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Satu Elo & Helvy Kyngäs. 2008. The qualitative content analysis process. *Journal of Advanced Nursing 62*(1), 107-115.

Subramonyam, H., Seifert, C. M., & Adar, E. (2021). Towards A Process Model for Co-Creating AI Experiences. *Designing Interactive Systems*. https://doi.org/10.1145/3461778.3462012

Van Allen, P. (2018). Prototyping ways of prototyping AI. *Interactions, 25(*6), 46–51. https://doi.org/10.1145/3274566

Wild, P. (2008). HCI and the analysis, design, and evaluation of services. BCS-HCI '08: Proceedings of the 22nd British HCI Group Annual Conference on People and Computers: Culture, Creativity, Interaction - Volume 2 (pp. 207 - 208). https://dl.acm.org/doi/10.5555/1531826.1531892

Winter, M., & Jackson, P. (2020b). Flatpack ML: How to Support Designers in Creating a New Generation of Customizable Machine Learning Applications. In *Lecture Notes in Computer Science* (pp. 175–193). Springer Science+Business Media. https://doi.org/10.1007/978-3-030-49760-6_12

Wu, Q., & Zhang, C. (2020). A Paradigm Shift in Design Driven by AI. *Lecture Notes in Computer Science*. https://doi.org/10.1007/978-3-030-50334-5_11

Yang, Q., Scuito, A., Zimmerman, J., Forlizzi, J., & Steinfeld, A. (2018). Investigating How Experienced UX Designers Effectively Work with Machine Learning. *Proceedings of the 2018 Designing Interactive Systems Conference*. https://doi.org/10.1145/3196709.3196730

Yang, Q., Zimmerman, J., Steinfeld, A., Carey, L., & Antaki, J. F. (2016). Investigating the Heart Pump Implant Decision Process. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/2858036.2858373

Zdanowska, S., & Taylor, A. S. (2022). A study of UX practitioners roles in designing real-world, enterprise ML systems. *CHI Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/3491102.3517607

V.A. Zeithaml, M.J. Bitner, D.D. Gremler. *Services Marketing: Integration Customer Focus Across the Firm* (fourth ed.), McGraw-Hill, New York (2006)

Zhang, Y., Wu, J., Xu, C., & Zhou, M. (2019). Intelligent Service System Design of Food Therapy Experience into Chronic Disease. *Springer EBooks,* 382–392. https://doi.org/10.1007/978-3-030-23538-3_30

Zhou, Z., Sun, L., Zhang, Y., Liu, X., & Gong, Q. (2020). ML Lifecycle Canvas: Designing Machine Learning-Empowered UX with Material Lifecycle Thinking. *Human-Computer Interaction, 35*(5–6), 362–386. https://doi.org/10.1080/07370024.2020.1736075

Zimmerman, J., & Forlizzi, J. (2013). Promoting service design as a core practice in interaction design. *5th IASDR World Conference on Design Research 2013. IASDR 2013.*