Human-centered design for advanced services

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ABSTRACT

Product-oriented companies are embracing new methods to create value, boost customer satisfaction, and improve their market position. One such method is through servitization, where companies offer bundles of products and services (PSS) to enhance customer satisfaction. Advanced services, a type of PSS, go further by offering features like risk and revenue sharing with customers throughout the service's life cycle.

However, designing these advanced services requires a human-centered approach. Existing methodologies often overlook human factors, leading to confusion and ineffective implementation. To address this gap, this study aims to identify key design elements and develop a conceptual multidimensional design methodology called DIMAND. DIMAND integrates life-cycle service design with stakeholder networks, new service development methods, and design skills to create effective advanced service design.

By considering these elements holistically, DIMAND provides a comprehensive guideline for design practitioners and engineers, enhancing coherence in all life-cycle design processes. This approach makes the design of advanced services more practical and sets the stage for future research in the field.

MATERIALS & METHODS

The study outlines the approach used to develop the multidimensional design methodology for advanced services (DIMAND). The research started with a unique attempt to investigate the literature characteristics and lessons learnt derived from a collection of 43 case studies regarding HCD in the context of Industry 4.0 [i, iv, v]. This attempt is completed by a well-rounded systematic literature review whose special unit of analysis is given to the case studies. As a result, the most significant finding (22 out of 43 case studies) was related to the identification of key design elements regarded as design success factors.

On the next research phase, a hybrid research design was employed by leveraging systematic reviews and meta-analyses of 21 existing design methodologies to extract these key design elements and their interrelations. These design methodologies were oriented towards addressing various aspects of advanced service design, including life-cycle service design, stakeholder networks, new service development methods and design skills (**RQ1**).

The design skills were identified through a systematic approach to gather skills required for effective advanced service design, thereby contributing valuable insights from experts in the field to the development of DIMAND. This process utilized questionnaire-based surveys administered to a purposively selected group of individuals possessing expertise in both academic and industrial perspectives [ii]. The survey methodology facilitated the collection of data regarding the specific design skills deemed essential for advanced service design. To enhance research validity, an analytical hierarchy process (AHP) was applied to design closed-ended questionnaires, ensuring the elicited responses accurately reflected the expertise and insights of the surveyed experts.

To synthesize all identified key design elements, the study utilized an ontology-based approach [iii], formalizing the relationships between the key design elements within the domain of advanced service design. This approach allowed for the development of a structured framework that integrates the identified design elements and their interdependencies (**RQ2**). Additionally, the study customized a correlation matrix to visually represent the interconnectedness of the design elements, resulting in the creation of DIMAND as a single and multidimensional structure. This framework provides guidance for design practitioners and engineers to navigate the complexities of advanced service design, ensuring comprehensive coverage of key design elements and their relationships.

Finally, DIMAND underwent a rigorous evaluation process involving experts and design practitioners in advanced service design. These experts and practitioners, chosen for their expertise in human-centered design, service innovation, and multidisciplinary methodologies, provided feedback on DIMAND's relevance, applicability, and comprehensiveness.

CONCLUSIONS

The study has made significant contributions to the field of advanced service design by addressing key research objectives. It identified and synthesized the key design elements necessary for an effective human-centered design (HCD) methodology for advanced services. These elements include life-cycle service design, stakeholder networks, new service development methods, and design skills.

Through a systematic literature review, the study established the importance of integrating these elements into a unified view structure. This led to the conceptualization of DIMAND, a multidimensional design methodology for advanced services. DIMAND was developed based on a hybrid research methodology, incorporating insights from existing design methodologies and feedback from design practitioners and engineers.

Theoretical contributions include filling gaps in existing literature by providing a comprehensive methodology that addresses all life-cycle phases, incorporates human actors, and integrates diverse service development methods and design skills. Practical contributions enable design practitioners to create advanced services more effectively by considering process dependency, stakeholder involvement, and transdisciplinary approaches.

Despite its contributions, the study acknowledges limitations such as potential biases in the review process and the limited generalizability of expert-driven research on design skills. Future research should focus on field implementations of DIMAND through longitudinal studies to refine the methodology and gather insights from practical applications.

 # RQ1 What are the key design elements of an effective HCD methodology for advanced services?

 # RQ2 How are the identified key design elements and their relations incorporated in a single-view structure in accordance with a human-centric approach?

i **Systematic literature review**

ii **Elicitation of expert knowledge on design skills**

iii **Conceptualization of new HCD methodology for advanced services (DIMAND)**

OBJECTIVES

To advance the body of research, this study aims to (i) identify key design elements of an effective HCD methodology for advanced services, and (ii) develop a conceptual multidimensional design methodology, called DIMAND for short, that incorporates the identified key design elements and their relations in a single-view structure in accordance with a human-centric approach.

The first aim is addressed through a systematic literature review of case studies in HCD in industry 4.0, revealing key design elements as success design factors of an effective HCD methodology. Based on the findings, DIMAND was conceptually developed through systematic reviews and structured analysis of existing design methodologies, as well as an elicitation of expert knowledge in the domain through the analytical hierarchy process (AHP).

Specifically, DIMAND encapsulates the (i) life-cycle service design interrelated with other key design elements—(ii) stakeholder networks, (iii) new service development methods, and (iv) design skills—that must be considered to develop effective advanced service design.

RESULTS

The results of the study yielded significant insights into the development and validation of DIMAND. Initially, the comprehensive review of existing design methodologies focusing on HCD for advanced services elucidated the fundamental principles essential for effective service design. Through a meticulous synthesis of 21 diverse design methodologies, a comprehensive understanding of the key design elements crucial for advanced service design emerged, encapsulating aspects such as life-cycle service design, stakeholder networks, new service development methods, and the requisite design skills.

Moreover, the evaluation process involving experts in advanced service design played a pivotal role in refining DIMAND. Their invaluable feedback on the methodology's relevance, applicability, and comprehensiveness ensured its adaptability to address the evolving landscape of advanced service design challenges. Furthermore, the customization of a correlation matrix served as a visual representation of the intricate relationships among the various design elements within DIMAND.

DIMAND not only enhanced the conceptual clarity of the methodology but also provided design practitioners and engineers with a practical tool for navigating the multifaceted dimensions of advanced service design. By delineating the interconnections between different facets of the design process, the correlation matrix facilitated a holistic approach to service design, thereby reinforcing the usability and effectiveness of DIMAND as a unified framework.

In summary, the results underscored the comprehensive nature of DIMAND as a meticulously crafted methodology rooted in HCD principles. Through a synthesis of research findings, expert feedback, and graphical representation, DIMAND emerged as a robust and adaptable framework capable of guiding design practitioners through the intricacies of advanced service design, thereby facilitating the creation of innovative and user-centric service solutions.

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ACKNOWLEDGEMENT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 814078