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Explainable AI System: The Proposed SmaSer (SS) Analytical Framework Enables Smart Service Design

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Abstract. The research on eXplainable Artificial Intelligence (XAI) has significantly increased, and XAI has been viewed as focused on the interpretation of machine learning (ML) models and the formation of explanations. However, the black-box nature of the AI technical process has led to difficulties in comprehending the systematic workings, particularly in innovative smart services. This study aimed to increase the transparency of the AI technical application and process through user experience (UX) investigation. This study proposes an analytical framework: SmaSer (SS), and it focuses on the process of understanding how smart services achieve user experience objectives while analyzing user needs, which, by creating co-creation tasks, drives the interaction between AI-enabled design and users. To meet this goal, the design team developed the FFRDSS systematic design framework for online-to-offline shopping services focused on fresh flower products, grounded in marketing needs, the flower industry, and the e-commerce environment. This empirical study explores the effective use of the SS framework in smart-service concept design, examines its application in AI-enabled design.

Keywords. Smart service, service systems design, artificial intelligence, user experience, framework analyses

1. Introduction

Technology supports human performance in high-level cognitive tasks, and simultaneously, the concept of trust depends on the intelligibility of a system's actions, reasoning, and potential mistakes [1]. The research on eXplainable Artificial Intelligence (XAI) has significantly increased; subsequently, XAI has been viewed as addressing the interpretation of machine learning (ML) models and the formation of explanations, which has also evolved with the development of context-specific methods [2]. AI successes are largely attributed to new ML techniques that construct models with complex internal representations, e.g., reinforcement learning (RL) and deep learning (DL) neural networks [3]. In smart service design, using innovative services to address specific user needs can be defined as leveraging the expertise of data exchange and AI-enabled technology, which requires relevant AI techniques and models. The essential

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requirements of smart design involve understanding user experience (UX) within their particular contexts of use, determining how UX can be accepted and transferred during service, and clarifying the processes by which AI technology supports these emergent data. Therefore, it is crucial to understand how smart services can be adopted by users and stakeholders, and how this understanding can guide designers in developing smart interventions and enhancing the interaction of users with AI smart techniques in particular scenarios. However, the black-box nature of the AI algorithmic process has created challenges in comprehending the systematic workings of AI [3], which impacts the structuring of UX and UI (user interface) to ensure usability for end users. To address this, this study aims to increase the interaction transparency of the AI technical application process in smart service design. Related research has been driven by many concerns, including new statistical learning algorithms, the availability of large datasets, and low-cost yet powerful hardware [4]. Linking this to the previous design study [5], HCI techniques applied to PSS design were described as an engineering solution, e.g., the service blueprint (SB) technique, which explains the interactive activities between service schemes and users' activities in a cyber-physical environment. The study [6] by Ribera and Lapedriza discussed related issues of explainability in ML, referring to prior studies. Interpretable machine learning (IML) is defined in a more restricted sense as involving the use of models that are not black boxes, while explainable ML (XML) refers to situations where black-box models are used and explanations are provided afterward. This discussion highlights considerations for explainable ML interventions when black-box models are used in various contexts to enhance understanding of the embedded AI technology's function.

This study proposes an analytical framework: SS (SmaSer). It focuses on the process of understanding how smart services achieve user experience (UX) objectives while analyzing user needs and preferences, thereby facilitating the creation of co-creation tasks that drive the interaction between AI-enabled design and users. This aligns with research on the explainability of AI, e.g., exploring the role of explainability and transparency in individualized recommendation services. Secondly, by introducing an FFRDSS systematic design process, the SS framework was utilized to analyze the opportunities presented by AI application supports in service systems, which validated the SS framework. As part of this process, the study developed the product-service system (PSS) design of FFRDSS using the proposed TRIZ method outlined in prior work [5]. Thirdly, discuss how the SS framework can be utilized to contribute to new systematic design concepts based on the empirical study.

2. The proposed SS analytical framework

The proposed SS analytical framework (see Figure 1) sets the goals of explanation design based on the requirements for explainable systems and is rooted in three key points:
1. Understanding the rules governing the decision process to detect possible biases.
2. Understanding the model and dataset to compare different models and avoid failures.
3. Extracting distilled knowledge from the AI system.

The framework was created to design AI-enabled system components for smart services based on the task-tool model. It focuses on the process of understanding how smart services achieve user experience (UX) objectives, along with analyzing user intentions by creating co-creation tasks that facilitate interaction between AI-enabled systems and users.

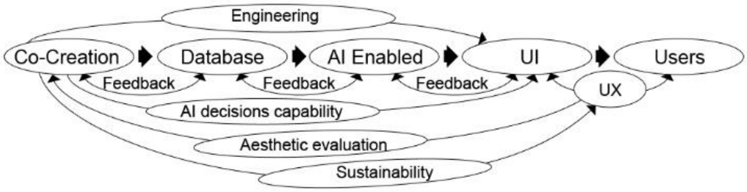

Figure 1. Conceptual SS analytical framework for the AI-enabled design.

Figure 1 shows an AI-enabled co-creation process, including five characteristics: co-creation, database, AI-enabled, UI, and users, illustrating a co-creation task in which an AI algorithm processes user actions to support data processing. Within the task, users' actions are divided into frontstage and backstage users, representing the design process as it relates to AI. The UI acts as an interface with touchpoints, including tangible devices such as mobility and smart devices, where interactions are structured between the user and the AI. To enable the delivery of smart services, the support technology components involve internal and external databases and non-contact employee actions. The interaction process, starting from user activity/action, leads to an investigation that is stored in the database. The AI algorithm enables data transformation between UX and AI agents, and the implementation can be simplified into three steps as follows: 1. At the touchpoint, user actions generate real-time data. 2. To create decision tasks, AI components process the generated data. Related data acquired from the database is also integrated and processed alongside the generated data. 3. AI algorithms finalize the data processing. Subsequently, decisions involving UX engagement are made and transferred to the touchpoints.

These steps bring out the challenge, as prior studies on expert system design revealed issues related to the opacity of a system's reasoning [1]. However, the systematic design phase between UX and AI technology often remains separate, with limited connectivity between them. The key point is that UX can be engineered through visual design techniques, e.g., user interface design, journey mapping, and by integrating AI data processing into model creation. This approach aims to create an effective and reliable systematic explanation for AI that is user-friendly. The SS framework serves as a tool to assist designers in gaining user-centered insights into the working process of AI technology and the communication of information across diverse users, e.g., sellers, employers, and service providers. By iteratively coordinating these insights, the framework measures the transparency of interactions between the AI algorithmic process and UX.

3. Methodology

The proposed TRIZ method for PSS design was utilized in this study [5]. The method emphasizes sustainable design and comprises three stages: problem definition, solution generation, and embodiment with evaluation. These stages aim to evaluate solutions generated through embodied design within systematic service areas [7]. The design process for AI-enabled smart mobility services was coordinated across stages 2 and 3 and followed three design steps: concept proposal, discussion, and evaluation. While exploring design insights to examine UX, the SS framework was employed to analyze the current mobility service delivery system and identify opportunities for AI technology support. To meet the goal, the research-based design implemented the proposed TRIZ-based method, showcasing how the framework can support smart services. The design team was tasked with developing the FFRDSS systematic design for online-to-offline (O2O) shopping services focused on fresh flower products and grounded in marketing needs, the flower industry, and the e-commerce environment. The research was conducted with seven designers from Yunnan University of Finance and Economics, China. The design process comprised two phases: marketing research and concept design, both initiated with input from the marketing research results. The research explored the needs and preferences of various user types. Typically, user-centered design involves surveys conducted through questionnaires, interviews, and site observations. In this study, the market survey collected, analyzed, and generated actionable results.

4. FFRDSS systems: the result of the smart service design

Based on the TRIZ method analyses, we concentrated on the primary useful function and developed a functional analysis diagram that extended to related problems. For the required customer experience, the design ensured that the primary useful function of the scenario redesign was to provide system operations that integrate products and services. From these, new information technologies and smart lockers with self-service solutions were allocated to meet the various needs of stakeholders. In this context, customer satisfaction was achieved through the useful functions (UF) of improving the availability of smart lockers and enhancing the usability of the operational systems. However, harmful functions (HF) emerged, including increased costs due to higher system maintenance expenses and a greater demand for technical support. To address these contradictory relationships, we defined the scope of the problem to include physical product availability, online operation usability, service system maintenance costs, and technical support costs.

Following TRIZ principles, we defined the smart locker systematic services as a conceptual design prototype to create an HCI environment in which users could operate effortlessly. Additionally, the FFRDSS smart service concept was designed not only to provide fresh flower products to fulfill online orders from buyers but also to offer offline services, such as order delivery and supply. According to the TRIZ contradiction matrix, we suggested adapting specific inventive principles to generate design resolutions. These resolutions were iteratively analyzed based on previous stages, resulting in the following user service divisions: 1. Systematic, multi-functional design 2. Flexibility features for the smart locker 3. Adaptation design tailored to the local context 4. Suitable usability for various user segments 5. Design divisions based on useful functions. In the concept-oriented strategies for the embodied design stage, we created, structured, and divided the service activities among the following users: customer, service provider, seller, and delivery operator, based on the specific situation.

5. The SS framework tool for FFRDSS

For solution evaluation, the embodied design was developed using 3D computer-aided design (CAD), and a series of visual solutions were presented, such as UI effects, blueprints, and 2D and 3D prototypes. The service concept was modeled as 3D prototypes [5], through which various systematic engineering methods were incorporated into the system designs. One model of O2O shopping services reflected the co-production chains: Smart lockers service delivery, primarily used for express delivery services through online shopping.

For smart lockers, for instance, the smart operation panels enabled self-service parcel delivery and pick-up operations. This process involved a user approaching the smart lockers and entering a pick-up code to retrieve a parcel after receiving a delivery notification (via mobile or internet) from the backend platform support. Suitable usability was designed for various user segments. Figure 2 illustrates that the O2O smart blueprint consists of eight rows with lines. The eight rows represent different components of online services, including evidence such as databases, AI data processing, online supports, etc. In the O2O integration, which focuses on the customer perspective, various tangible and intangible evidence is generated through different interactions.

Online service provider activities refer to actions through which users interact with online channels and support systems, where ML models potentially are built based on UX data and databases. These activities may involve online services accessed by customers through a computer, an application, or the Internet. Similarly, offline service providers include staff, officers, or sellers who meet customers onsite to fulfill their needs. Finally, customer actions refer to the specific tasks or interactions performed by customers during a service. The eight rows of the blueprint represent the O2O phases and components of the system, including 1. Online support systems 2. AI applying supports 3. Channels for online interaction 4. Channels for offline interaction 5. Offline support systems. These row components are interlinked with the rows and connect components across different levels of the system. The O2O support systems refer to devices (e.g., computers, smartphones, and technologies) that facilitate online and offline channel operations.

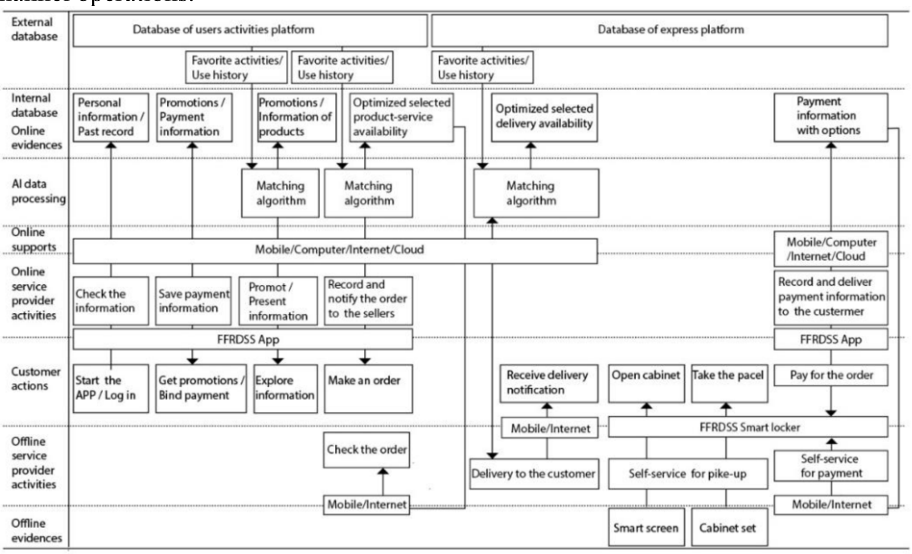

Figure 2. The created blueprint of smart locker service with the SS analyses.

6. Using the SS framework analyzed XAI

The SS framework enabled the analyses of the FFRDSS service delivery process. The interactions among user actions, frontstage and backstage employees, touchpoints, and databases were defined, as shown in Figure 2. Through framework analysis, a key consideration was how the design provides AI-applying support for customers' preferences by embedding AI technology into the personalized order service based on users' favorite activities. Specifically, a key necessity was identified and discussed for personalized orders for customers, as they have strong preferences in terms of individual experience (UX), e.g., needs and occupations when shopping for their favorite activities.

Conventionally, whenever employees place service orders, even with customers in-store, they repeatedly engage in probing user preferences to learn from various customers. However, this process lacks learning about customers' favorite activities and often results in spending a lot of time trying to understand user requirements. Sometimes, users' shopping intentions are unclear, which leads to more time-consuming communication. Furthermore, to a large extent, employees have to deal with many customers, making it difficult to remember the needs of each customer. How the design offers a smart platform to deal with the volume of data is the systematic design goal. It can provide a personalized order service for users who primarily choose to engage in their favorite activities and reduce employees' workload related to communication activities. Therefore, based on the requirement, enabling AI technology to establish a platform that can personalize orders for end users is an opportunity. AI, with an agent role, can be used to assist and replace some or most human work for co-creation with customers, which translates the FFRDSS into a smart mobility service.

According to users' feedback from the design group discussion, the concept was updated by adding the AI function "optimized decision-making and information processing based on user activity data." Figure 2 demonstrates the updated concept using the SS tool. Under this concept, the AI algorithms were embedded in the channels of AI data processing, enabling three parts of the decision-making process and information interactions: 1. Co-making decisions on personalizing orders based on users' favorite activities. 2. Promoting/presenting optimized product and service information. 3. Co-making decisions on delivery options based on users' real-time information onsite.

When FFRDSS users place an order related to their favorite activities, this function is supported by the algorithm and the database-driven. The internal database records and stores the user's favorite activity data, while the external database stores available activities that users can access in product-related shopping. The activity data is processed by applying AI, which then creates patterns of these activities in combination with the available activity data stored in the database.

7. Discussion

This empirical study effectively validated the SS framework and indicated that the framework analyses, using XAI technology e.g., AI-enabled models, UX factors, and service blueprints [3][6][4], can contribute to the systematic design. The service model is reflected in co-production chains: smart locker delivery services and physical store services [5]. The service concept is embodied and created as 3D prototypes in the mentioned FFRDSS study and O2O blueprints, by which various systematic engineering results were reflected in the systematic service processes and visual representations. These results indicated that the SS framework can be used to demonstrate a correlation between UX and AI while integrating user-centered design into the analyses of possible AI applications. The whole design process was demonstrated in Figure 2, which explained how the SS tool was applied in the AI-enabled design process of developing the systemic smart service in the situations, involved as follows: 1. This required an overall understanding of the design with an AI-enabled design process. This began by focusing on the existing requirements and problems, which were derived from the previous user survey, and the framework was deployed to analyze how the current product services could be schemed and provided. 2. Through a co-creation method, the concept of UX enabled by AI technology was critically discussed, and both user and stakeholder perspectives were considered and incorporated. The service blueprint created helps sort out how different types of users can interact in a shopping journey. The user journey starts when a customer intends to shop; the turning point of the online service occurs when an order is placed. Service activities thoroughly move on the touchpoint from O2O while generating new UX, which also proposes further user needs. 3. With AI algorithms processing new data, the UX can be transferred into the AI-enabled process in the system. The expected UX is generically translated to AI, and at the same time, it also receives the related data from the database. Afterward, the expected UX for the relevant AI technical decisions is generated. The study results shed light on the proposed SS framework, which was applied in a systematic PSS design and improved UX with the challenges of designing AI-enabled FFRDSS smart services. It was validated to benefit the design field. The case study thus created systematic products and services and achieved the aims with AI-enabled service innovation. The framework's concepts can be used to analyze the correlation between UX and AI while integrating various user views to explain the implications of possible AI technology.

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