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Research in Progress

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Abstract

For the IT industry, cloud computing has a disruptive effect, since it fundamentally changes how IT resources are produced, distributed, consumed, and priced. Designing cloud services remains a challenge, as the markets are very dynamic and cloud users are heterogeneous, locally distributed and not within the reach of the organization. This research-in-progress paper suggests the use of market research techniques, namely conjoint analysis, in the requirements elicitation process for cloud services. The contribution is a method component that extends existing requirements engineering methods. It supports cloud service providers in addressing specific questions of cloud service design: to analyse user preferences and the many trade-offs between different functional, non-functional and economic properties, to identify customer segments and develop tailored offerings, to analyse willingness-to-pay for specific features and to simulate market reactions of new designs.

Keywords: cloud services, user-driven design, requirements elicitation, conjoint analysis

1 Introduction

With the advances of the information and communication technology (ICT), IT is said to become the fifth utility (after water, electricity, gas, and telephony) (Buyya et al., 2008). Cloud computing has fuelled the paradigm shift from ownership to usage of IT resources by introducing a new model of service delivery and access where dynamically scalable and virtualized resources are provided as a service over the Internet (Rimal et al., 2010). The unique properties of cloud services “are the conversion of fixed cost technology to variable cost technology, fast setup time, and elimination of capacity constraint” (Chen and Wu, 2013). For the IT industry, the cloud paradigm elicits a need for more thoroughly defined IT services with clearly specified delivery and pricing models. However, designing cloud services remains a challenge due to cloud market dynamics and unknown user requirements.

This paper focuses on the software vendors’ perspective, for whom the move towards cloud computing is mostly associated with the provisioning of software as pay-per-use service. Software as a Service (SaaS) offerings are available for a wide range of business functions, including customer service, pay-roll, financial applications, or e-mail (Laplante et al., 2008), but integrating hardware and software as a service offering has changed traditional software development. Due to continued acceleration of SaaS applications, the SaaS market is increasingly competitive. Additionally, Platform as a Service (PaaS) offerings provide programming and runtime environment for cloud-based development. They involve transformation of SaaS offerings into platform-based offerings and open up new customer segments and value propositions (Giessmann and Stanoevska, 2012). Hence, to sustain in the market software providers need to understand consumers’ preferences and requirements in order to design and adjust their SaaS and PaaS offerings accordingly.

However, existing requirements engineering (RE) techniques do not fit the cloud particularity as they mostly rely on close interactions between developers and the user groups. Although some RE literature has addressed this issue in the context of commercial off-the-shelf (COTS) software (Jarke et al., 2011; Buxmann et al., 2013), the application of traditional methods has proven not to be very successful for cloud providers due to the heterogeneity and the distributed nature of the cloud users (Todoran et al., 2013). Incorporating the “voice of the customer” is a critical success factor for developing high-utility cloud services. Yet, this step is often ignored or poorly executed by cloud service providers, where requirement analysis remains an ad-hoc activity (Todoran et al., 2013). This motivates our research which asks: How can cloud service providers systematically elicit, analyse and simulate user preferences to support cloud service design? We argue that market research techniques specifically advanced conjoint analysis, can be leveraged in cloud service design and should extend existing RE methods. The previously conducted conjoint studies in the domain of cloud services have been so far one-time efforts. More methodological reflexions and domain-specific adaptations are needed to fully develop conjoint analysis into a suitable RE approach for cloud services. The contribution of this research-in-progress paper is a first version of a method component for the user-oriented design of cloud services, including a cloud user preference model and methodological guidelines.

The remainder of the paper is structured as follows. Section 2 motivates our research gap through a literature review on cloud service design, the requirements engineering challenges of mass-market IT services, and the application of market research techniques to IT solutions. Section 3 outlines the research objectives and methodology. Section 4 provides an overview of the suggested method component and presents some first results. Finally, section 5 presents a summary and the next intended steps.

2 Literature Review

2.1 Cloud services from the user and provider perspective

Cloud services separate the ownership of IT resources from their usage and, consequently, are likely to be attractive for a larger user base than traditional on-premise systems. For *IT vendors and service providers*, the design of IT solutions gets more challenging with cloud computing: First, cloud services introduce innovations and may even be disruptive, because they bring functional features and economic value propositions yet unknown to the market (Cusumano, 2010). Second, designing cloud services goes clearly beyond traditional systems design, since it embraces on-demand service delivery and requires a viable business model for offering pay-per-use services. Compared to on-premise systems, cloud services' provisioning and their non-functional properties, such as high-availability, scalability, reliability or security, gain in importance. This shift is mirrored by a very lively research stream dedicated to quality-of-service or security aspects in cloud computing (Kandukuri et al., 2009; Patel et al., 2009). Besides the provisioning aspects, the new business models and the emerging pay-per-use pricing and revenue models have attracted researchers' attention (Eurich et al., 2011; Weinhardt et al., 2009).

Users are confronted with a rapidly increasing offering of cloud services and find it also difficult to evaluate cloud services given the various level of performance and different economic models. Several approaches in research and industry have been suggested to facilitate the selection of cloud services to fit users' needs respectively requirements. Tools like ComparetheCloud.net, CloudReviews.com or CloudScreener.com assist potential cloud service consumers in selecting the most adequate cloud service according to their requirements. The Cloud Service Measurement Initiative Consortium (CSMIC) proposes the Service Measurement Index (SMI) framework allowing a comparative evaluation of cloud services. The SMICloud tool suggested by Garg et al. (2013) is based on that framework and allows to rank cloud services based on their ability to meet the user's Quality of Service (QoS) requirements. With the CCCloud model Qu et al. (2013, 2015) propose a cloud service selection model that scores cloud services based on aggregating subjective assessment from cloud users and objective assessment from third party performance testing to reflect the service quality and facilitate selection. Further academic studies dealing with cloud services selection are Höfer and Karagiannis (2011), Zardari and Bahsoon (2011), Godse and Mulik (2009), Rehman et al. (2011), Sun et al. (2014), Tang et al. (2015), Wang et al. (2015).

2.2 Requirements engineering – conventional solutions to cloud services

Requirements engineering (RE) as a "branch of software engineering" (Zave, 1997) refers to "the process of discovering, documenting and managing requirements" (Sommerville and Sawyer, 1997). It "is a cooperative, iterative, and incremental process, which aims at ensuring that (1) all relevant requirements are explicitly known and understood at the required level of detail, (2) a sufficient agreement about the system requirements is achieved between the stakeholders involved, as well as [ensuring that] (3) all requirements are documented and specified in compliance with the relevant documentation formats and rules" (Pohl, 2010). In the meantime, "the ongoing shift in how software is made - from user organizations developing their own to a market in which vendors package ready-to-install products - means fundamental changes in how information systems are developed" (Sawyer, 2001).

To understand users' needs and produce commercially successful software, a large number of techniques and approaches for requirements elicitation exist (Zowghi and Coulin, 2005), comprising 1) traditional data-gathering techniques, such as interviews, surveys or document analysis, 2) group elicitation, 3) prototyping, 4) contextual techniques, 5) cognitive techniques, and 6) model-driven techniques. Most of these techniques rely on close interactions between software developers and groups of users or their representatives. In mass-market scenarios, these methods face a number of issues with establishing two-way interactions with stakeholders as well as participant selection and requirements representations. They are therefore criticized for not adequately addressing the specific needs of modern information systems for "wide-area end users" (Tuunanen, 2003). These specificities have been discussed in the context of commercial off-the-shelf (COTS) software that is generally developed based on "market-driven vendor-led requirements" (Jarke et al., 2011) and addresses "the lowest common denominator in terms of users' needs" (Buxmann et al., 2013). COTS software development requires specific approaches (Sawyer, 2001): Deifel (1999) proposed a process model for requirements engineering of complex COTS software, that "describes a systematic way in which collected requirements can be brought to a concrete version plan". Carmel and Becker (1995) identified eight special needs for COTS software design and operationalized them into a packaged software process model. Further studies on RE for COTS are Alves and Finkelstein (2002), Rolland (1999) and Potts (1995).

Requirements engineering becomes even more challenging with cloud computing, according to a recent study (Todoran et al., 2013): First, cloud providers do not have an easily exploitable consumer base to involve in the elicitation process, and, second, existing methods from the mass market domain do not suffice for cloud providers' needs. Based on an exploratory study of 19 cloud providers, the large majority uses ad-hoc approaches for identifying customer needs, due to a number of challenges, such as the reachability of customers or a complete lack of development strategy. As a conclusion, "elicitation methods for cloud providers should apply for diverse consumers, enable a shorter time to market, be applied remotely and ideally asynchronously" (Todoran et al., 2013). The same authors have started to develop StakeCloud, a community platform that serves as a cloud resources marketplace, and that will allow consumers to input their needs and communicated new requirements to cloud providers (Todoran and Glinz, 2012; Todoran, 2012; Koitz and Glinz, 2015).

2.3 Applying market research techniques to understand user preferences

Understanding consumer preferences is a crucial point in designing cloud services, as "the most important cloud entity, and the principal quality driver and constraining influence is, of course, the user" (Vouk, 2008). However, these preferences are far from being easy to grasp because of the novelty of the cloud paradigm and the many trade-offs between different functional, non-functional and economic properties. This calls for new approaches and, since cloud services extend the scope of IT solutions to the individual user, the use of market research techniques.

Conjoint analysis (CA) as "[...] a practical set of methods for predicting consumer preferences" (Green and Srinivasan, 1978) has become the most used marketing research method in the last decades. Its popularity in consumer research is due to the fact that it allows for analysing consumers' trade-offs, by identifying consumers' part-worth utilities for attributes and attribute levels (Green et al., 2001). In conjoint analysis, products or services under consideration are described by attributes and attribute levels, also referred to as stimuli. Participants place these products or services in a rank order that corresponds to their individual preferences. It is assumed that these stimuli are viewed and CONsidered JOINTly by the participants (Backhaus et al., 2013). A conjoint procedure includes five main steps: 1. defining attributes and attribute levels, 2. conceptualizing the survey design, 3. collecting data via participants, 4. estimating utilities and 5. aggregating part-worth utilities.

Until now, market research techniques are not yet fully leveraged to support the user-oriented design of IT solutions, even so Van Kleef et al. (2005) argued that conjoint method might be leveraged in new technical product development. Among the few studies applying CA in information systems research are Keil and Tiwana (2006) for ERP software package evaluation. Five other studies leverage conjoint analysis for studying user preferences in the cloud services context: Doerr et al. (2010) explored consumers' utility and their willingness to pay for Music as a Service and detected that next to price, contract duration and music quality are the most important product attributes. Koehler et al. (2010) performed a choice-based CA on consumers' preferences for cloud services in general and found that on average reputation of the cloud service provider and the use of standard data formats are more important than those financial aspects such as cost reduction or pricing tariff choice. Krasnova et al. (2009) used CA to investigate the value of privacy in online social networks and identified three groups of users with different utility patterns. Giessmann and Stanoevska (2012) investigated consumers' preferences on Platform as a Service, they performed an adaptive choice-based conjoint analysis (ACBCA) from which a prioritized list of customers' preferences was identified based on the derived part-worth utilities of ten attributes and their defined levels. Within the same context, Giessmann et al. (2013) suggest market simulation for cloud business models to facilitate cloud service design. Most recently, Burda and Teuteberg (2014) investigated consumer cloud storage choice decisions performing choice-based conjoint analysis.

2.4 Research gap

Two important and relevant research gaps were identified: (1) *Domain-specific adaptation of conjoint analysis:* The few CA studies on cloud services confirm that this technique provides valuable insights for cloud service design, but they have been so far one-time efforts. We lack a more thorough discussion on methodological aspects and domain-specific adaptation of conjoint analysis. (2) *Extension of requirements engineering methods:* Traditional approaches rely on analysing individual requirements in close interaction with users, but lack methodological support for systematically eliciting user requirements in mass-markets. Market research techniques, such as conjoint analysis, can be applied remotely with distributed participants and add user preference measurements to the traditional set of requirements elicitation techniques.

3 Research Goals and Method

In view of the existing gaps, our research objective is to extend requirements engineering methods for designing commercial cloud services in mass markets through market research techniques. More specifically, we aim to develop, apply and evaluate a method component for eliciting and analysing user preferences to support cloud service design. The suggested method component (in line with Karlsson and Wistrand (2006)) adapts advanced conjoint analysis techniques to cope with the specificities of cloud services and provides methodological guidance in applying them.

In developing the method component, we follow a design science research approach (Hevner et al., 2004; March and Smith, 1995). According to Hevner et al. (2004) design science research in information systems (IS) must produce purposeful artefacts – in our case a cloud user preference model and a method component – to address an important organizational problem. It usually happens as a build-and-evaluate process. Following the design science research methodology (DSRM) suggested by Peffers et al. (2007), we conduct our research in six iterative steps (Figure 1):

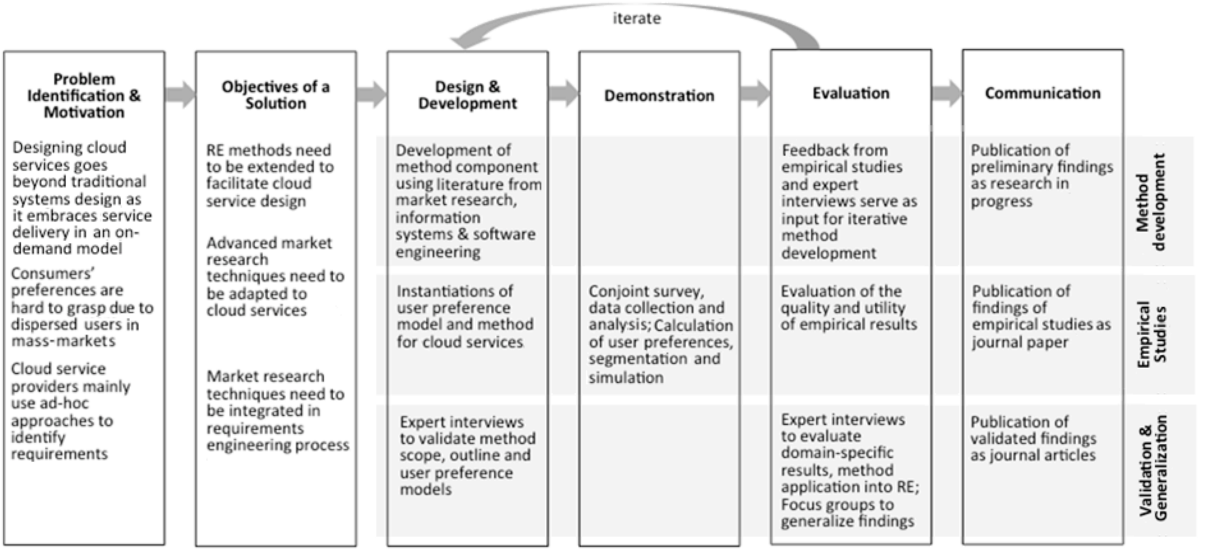

Figure 1. Research process, based on (Peffers et al., 2007)

The first two steps in the research process – **problem identification and motivation** and **objectives of the solution** are discussed based on the previous section where we present literature on cloud service design and the challenges in their requirements engineering process. At the **design and development** stage, the design of the artefact, i.e. the method component, follows method-engineering guidelines and integrates theoretical foundations from literature on market research and its use in information systems design, as well as requirements engineering. As **demonstration and evaluation** of our method component, the evaluation is through designing conjoint surveys for two specific types of cloud services. These studies will provide empirical insights into consumer preferences for distinct cloud services and comprise simulations of cloud service design decisions. Based on the outcomes, iterations will be performed to improve the method component. In order to **validate and generalize the findings**, it is necessary to conduct expert interviews and work with focus groups along the research process.

4 Method Component

The proposed method component extends existing requirements engineering methods through a tailored market research approach for mass-market cloud services. It concentrates on the elicitation and analysis of requirements or, as Pohl (1994) describes it, specification, representation and agreement. As method component, we denote "a self-contained part of a systems development method expressing the transformation of one or several artefacts into a defined target artefact and the rationale for such a transformation" (Karlsson and Wistrand, 2006). The method component comprises three model elements that address relevant aspects in cloud service design and provide methodological guidance (see Table 1). It builds on the CA techniques used in prior studies and further extends them:

1. *A cloud user preference model* comprising the relevant dimensions for cloud services along with a rigorously developed and validated catalogue of attributes and attribute levels.
2. *A technique for user preference elicitation and analysis* to measure and analyse user preferences and intentions to buy related to cloud services and derive market segments.
3. *A technique for simulating cloud service design decisions* to analyse how users react to changes in current cloud services or to new services introduced, and to predict market shares.

Scope of the suggested method component for cloud service design (in comparison to existing conjoint analysis studies)	**[1] Doerr et al., (2010)**	**[2] Koehler et al. (2010)**	**[3] Krasnova et al. (2009)**	**[4] Burda and Teuteberg (2014)**	**[5] Giessmann et al. (2012, 2013)**	**Suggested Method**
1) Cloud user preference modelling						
Deduction of suitable attributes and attribute levels	◕	◑	◕	◕	◕	●
Dimensions of cloud services with attributes and levels	○	○	○	○	◔	●
Partial profile conjoint based on domain knowledge	○	○	○	○	○	●
2) User preference elicitation and analysis for cloud services						
Support for selecting the appropriate conjoint analysis variant	○	○	○	◔	○	●
Cluster analytic methods for post-hoc segmentation	○	◑	◕	◕	○	●
3) Simulation of cloud service design decisions						
Expected market share	○	○	○	○	◕	●
Customers' willingness-to-pay for dedicated features	◑	○	○	○	○	●
Interaction effects of cloud service attributes	○	○	○	○	○	●
Legend:	○ *not covered*	◔ *somewhat*	◑ *partially*	◕ *mostly*	● *fully covered*	

Table 1. Scope of method component for requirements engineering to be developed

4.1 User preference modelling

A main methodological concern in both requirements elicitation and conjoint analysis is the determination of suitable attributes and attribute levels describing key design properties. A user preference model will accelerate the setup of CA studies and allow the comparison of their results for different cloud service categories. Using the traditional categories of requirements engineering – functional and non-functional requirements – is far than being sufficient for cloud services. Additional economic and operational aspects determine users' choices of cloud services (Cusumano, 2010). These requirements are mostly constituents of a cloud service business model.

Based on previous CA studies (section 2.3) and investigations on cloud service design, a mapping of attributes to an inclusive preliminary set of dimensions was derived (see Table 2). These dimensions will define the user preference catalogue that will contain refined sets of attributes and levels convenient to different service types (i.e. the service provider would be able to choose his attributes list for the target conjoint study based on the catalogue definitions).

Dimensions	**Mapped Attributes from Literature** *(Numberings refer to the studies presented in Table 1)*
Functionality **(in terms of features)**	• Content Quality [1] • Customization [1] [3] • Community Features [1] [3] • Storage Space [4] • Dev. Environment [5] • Test Environment [5] • Monitoring [5]
Pricing Model **(e.g. subscription or pay-per-use)**	• Pricing Tariff [1] [2] [3] [4] [5] • Contract Duration [1]
Relationship with cloud service provider	• Provider Reputation [2] • Network Popularity [3] • Market Penetration [5]
Delivery Services **(e.g. consulting or support)**	• Required Skills [2] • Customer Support [2] [4] • Migration Process [2] [5]
Accessibility **(e.g. supported devices and platforms)**	• Offline Access [1] • Mobile Application [1] [5] • Distribution Channel [1] • Accessibility [4]
Transparency **(e.g. location or technology)**	• Security and Reliability [2] • Information Use [3] • Privacy Control [3] • Encryption [4]
Partnerships **(e.g. hosting by 3rd party)**	• Marketplace Functionality [5] • Payment Handling by Marketplace [5]

Table 2. Dimensions list based on previous conjoint studies on cloud service design

To evaluate the defined dimensions, a survey was created to identify which criteria is regarded the most important in the choice of cloud services. The survey is distributed to IT professionals from different industry sectors including software, consulting, healthcare, education and research. The participants have to rate each attribute individually with a scale of (0-6). Preliminary results of 40 respondents are discussed in this paper. Ratings of more than 4 for the attribute are considered an agreement, and they give us the ordering of importance of attributes for further steps in the research. With a vast majority of high ratings, functionality (87.5%), accessibility (82%), and pricing model (80%) are considered highly important attributes for cloud service design. Transparency was rated important by 50% of the respondents who explained that the location of the service provider, the technology supported, and the use of the data are critical aspects. Partnerships as hosting by 3rd party had similar rating (45%). Finally, delivery services (35%) and the relationship with the cloud service provider (32%) had the lowest ratings. These results confirm the suggested key dimensions of design properties which we will complement by attributes and levels based on the previous CA studies, existing products' features and interviews from the planned empirical studies.

4.2 User preference elicitation and analysis for cloud services

This method element supports selecting the appropriate CA variant, which fits the cloud domain's specificities and the study's objectives. Depending on the type of CA variant, data collection (e.g. hybrid or adaptive) as well as the econometric and statistical methods to estimate utility functions may vary. Moreover, it provides guidelines for applying the relevant CA variants in the cloud services context. The implemented CA techniques would provide an analysis of: 1) customer preferences for attributes and attribute levels based on part-worth utilities, 2) users' sensitivity to different aspects (e.g. functional aspects, compared to privacy and security issues, or pricing and contractual terms), and 3) cross-elasticity effects, and interaction effects of attributes. Whereas previous research has focussed on the analysis of customer preferences for attribute and attribute levels based on part-worth utilities, we extend the set of suggested CA techniques to comprise cluster analytic methods. Compared to a-priori market segmentation, cluster-based segmentation identifies groups of customers sharing the same preferences, attitudes or trade-offs, and can be used to tailor targeted offerings.

4.3 Simulation of cloud service design decisions

Using the collected data and calculated individual utility vectors conjoint studies can be leveraged for market simulations to determine those attributes of a product or service which will maximize its share (Johnson, 1974). This method element supports simulation of variations in cloud service design with respect to the expected market reactions, by taking consumer preferences and competing cloud service offerings into account. On the one hand, we further elaborate three simulation techniques, which have been developed in a pre-study (Giessmann et al., 2013): 1) competition analysis, 2) direct benchmark analysis, and 3) attribute variation analysis. With the competition analysis, cloud service providers can compare their service with other services of the same type. Its results are the relative similarity (in %) as well as virtual market shares for cloud services. The direct benchmark analysis is a special case of the competition analysis related to comparison with another service. The result is one similarity value and two market shares, with a detailed attribute-wise comparison views between two services. The attribute variation analysis is an extension of the competition analysis: The user can view variations in market share of an existing service as a result to changes in selected attribute levels. On the other hand, we suggest simulations of customers' willingness-to-pay (WTP) and customers' willingness-to-accept (WTA). Such simulations are novel and of particular interest for the integrated functional, non-functional and economic cloud service design.

5 Summary and Outlook

Our research addresses existing gaps in research related to the user-oriented design of cloud services and the lacking requirements elicitation techniques for cloud providers. Its findings will contribute to different research streams: (1) By suggesting a method component that adapts advanced market research techniques to cloud services design, we enhance the existing set of requirements elicitation techniques to reach out to "wide-audience end users" and mass-market cloud services. (2) The domain-specific adaptations and methodological guidance for conducting conjoint analysis provide important groundwork for future academic studies on cloud services. The cluster-analytical methods and simulations address novel aspects related to requirements engineering for mass-market cloud services, such as post-hoc segmentation to tailor offerings, analysis of willingness-to-pay to prioritize product adaptations, attribute variations to understand trade-offs in cloud service design or benchmarking to identify differentiation potential. (3) As comprehensive approach to cloud service design, our findings allow for integrating software, operational and business model design.

As this research is still in progress, we have mostly been concentrating on the development of the method component (design and development stage, cf. section 3). For the demonstration and evaluation, two empirical studies will be conducted. The first study will be in the domain of customer relationship management (CRM) which is among the most popular cloud services (Correia et al., 2014). The second study will be applied to cloud checklist services, which are relatively simple applications that support users in managing and executing tasks. Compared to CRM cloud services, cloud checklist services are an emerging offering and will allow us to study a phase where no dominant design has emerged and cloud market dynamics are still playing.

For validation and generalization, expert interviews will be conducted to gather qualitative feedback on the cloud user preference model and the outline of the method component. Particular emphasis will be given to defining the purpose and scope of the method component and its integration into the requirements engineering process, i.e. discovery, specification, validation and verification (Jarke et al., 2011). In later stages, experts from the domains covered in the empirical studies are asked to evaluate the quality of conjoint analysis results and the method's applicability and utility for requirements engineering (ex-post evaluation), using a qualitative and a quantitative evaluation (scoring model to rate the method component). Additional focus groups with cloud service providers from other domains will be organized to validate the findings and to discuss the generalizability of the method component (ex-ante evaluation, with qualitative and quantitative evaluation).

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