Adding UX in the Service Design Loop: The Case of Crisis Management Services

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Abstract. Focus on user experience (UX) has been a growing trend in service design (SD), as it has various benefits. As it will be demonstrated in this paper, developing an efficient, yet usable crisis management service requires a deep understanding of the experience of all stakeholders involved in the crisis. While many SD studies have proposed different principles, practices and tools, there is a lack of a practical comprehensive design framework that empowers designers to integrate effectively UX in the SD lifecycle. In this paper we propose a methodological framework called UXD-IS (User eXperience Design of Interactions and Services) that combines UX characterization and touchpoints analysis. The framework has been validated through a case study related to flooding crisis management. The investigations reveal that the framework is a powerful support tool during the first phases of the development of a new service or the improvement of an existing one.

1 Introduction

Crisis management services are undergoing major and fundamental changes in all countries around the world. This is a result of a number of convening forces including public budget cuts, demographic shifts, massive immigration, urbanization, environmental challenges, terrorism risks and rapid technological change [1, 2]. Like many other public service systems (e.g. public health care, transportation, sustainability development), the crisis management service design is complex and highly challenging. There are many stakeholders involved, including organizations, as well as numerous participants and things that make the entire service function. Improvement and maintenance are especially difficult, as the designers should take into account new situations and user experiences (the term user refers to any person interact with one or more service interface).

Thus, user experiences, including needs, expectations and attitudes, should ultimately guide how the entire service-system is being designed and managed [3]. At a time of major restructuring and reform, a participants-centered approach is what is needed.

This is where service design (SD) is extremely relevant. SD considers the quality of the service from the human perspective as a key pillar [4]. However, the service designers' community, despite the considerable research efforts, often neglects the analysis and evaluation of the user's experiences. Moreover, service design raises several challenges in terms of user experience (UX), overpassing traditional usability aspects [5].

Crisis management services are an example of complex user-service interactions [6]. Indeed, the emergency of an unforeseeable crisis situation can have an impact on the work of intervening actors – precisely on decision-making and coordination between the different participants and implied organizations [7]. The experiences generated before, during and after using crisis management services should constitute a solid information design to improve the existing services as well as to innovate in the design of new services. This finding was already raised by Turoff et al. [8], who described one of nine crisis management system design premises called "crisis memory": learning and understanding what actually happened before, during, and after the crisis is extremely important for the improvement of the response process.

In this sense, UX design has emerged as a research field seeking to offer a systematic approach to design and evaluate the user's holistic experiences with service technology. UX refers to users' perceptions and responses that arise in the use of a product, system or service [9]. In human- computer interaction (HCI), user-centered design and service design disciplines, the design of desirable human experiences has been one of the major interest areas in service UX design. The user- service interaction being the focus, service design methods may be used for improving the UX of a service interface, the visible part of the service to the users, thus stimulating behaviors and choices.

The key rationale and motivation for adopting a UX design approach for the design of crisis management services are broadly highlighted hereafter.

First, for a service-based system and organization, such as crisis management, the multitude of the underlying intervention equipment and technologies as well as the significant number of participants from the various sectors of an organization with their different characteristics (qualification, behavior, culture, etc.) make the design of those services highly challenging. Moreover, from the user side, the end-user must be able to reconfigure the service interaction in a dynamic manner and designate changes in priorities, filtering the options and delivery the decisions at any moment during his or her interaction with the given service. From the service side, however, it also means the service has to observe these changes dynamically and keep other participants up to date.

All issues previously cited make the precise evaluation of the impact of use of those services on the participants and broadly on the progress of the organization management process more critical. It is important to provide designers a methodological framework to capture and evaluate the quality of the UX during the journey of the user with a service and therefore deliver services that are more

innovative and desirable to end-users. In this paper we will focus on subjective evaluation of UX because it is rich and lends itself well to the capture of complex subjective experiences.

Secondly, the interaction analysis between the different users and service through various contact points, namely touchpoints, is often ignored or even non-existent despite several research works resulting from other application fields. For instance, studies about medical emergency [10], cloud computing [11] and e-learning services [12] have highlighted the relevance of adopting the UX design and the associated touchpoint technique in the service design life cycle. Furthermore, very few practical works have dealt with user-service interaction and the UX perspective.

We investigate the following research questions:

(a) How to capture and evaluate the attributes characterizing the UX at each user-service contact point?

(b) How to ensure a certain traceability between the UX descriptions and the created service designs?

(c) How the users should be involved in SD lifecycle since the users may also become developers of the service, or at least contribute to its content and how it appears to others?

Therefore, we need a methodological framework that use a correlated tools and techniques from both UX design and SD for purpose of narrowing the gap between UX and SD practices. More precisely, our research is tailored towards the definition of a process that identifies from multiple tools (i.e. personas, touchpoints and user-journey) the set of attributes in order to assess the UX quality of current service designs and also to detect pain points during the user-service interaction.

The remainder of this article is as follows. Section 2 reports related work on UX and its application in service design. In section 3, we give an overview of the proposed framework (UXD-IS). Section 4 shows the detailed description of UXD-IS phases applied to a real flooding crisis management case study. The evaluation of the proposed framework is described in section 5. Finally, in section 6, we discuss the main issues and ideas relative to the proposed approach as well as some lessons learned from the research practices, whilst concluding and suggesting some research perspectives.

2   Background

2.1   Service Design

From services marketing perspective, Polaine et al. [13] state that "Service design aims at designing services that are useful, usable and desirable from the user perspective, and efficient, effective and different from the provider perspective." They add "Services are systems that involve many different influential factors, so service design takes a holistic approach in order to get an understanding of the system and the different actors within the system." Service design is also defining

as holistic, co-creative, and user-centered approach to understanding customer behavior for the creation or refining of services [13, 14].

All these definitions agree that service design is co-creative, in that the design team works with stakeholders, (e.g., users and staff), to co-create or refine services that meet or adjust to customer (user) expectations, while also working with frontline personnel to deliver a high-quality service. At the center of the process is the user and insights into user behavior [13]. It is through this lens that services are refined and improved or even created to meet user needs and expectations.

Service designers use various tools and methods (e.g. user journeys, stakeholder maps, personas, service blueprints, prototyping) borrowed from a number of disciplines (e.g. social science, business and design) to understand the needs of users and (re)design services better to suit these needs. In HCI design, service design leads to a thorough analysis and deeper understanding of user-service interaction. The persona tool has been used to characterize the users targeted by the design [15, 16], and blueprinting has been defined as a process control technique for modeling the user-service interactions [17].

In the plethora of service design methods, different artifacts are used for portraying visually the design concepts and ideas [18, 19]. Most of them are applied according to the culture and skills of the stakeholders involved in the service processes [20]. The Double Diamond is another example of the service design methods [21]. Double Diamond is a process model inspired by the professional design process that entails emphasis on problem analysis as the basis for creating a solution for an external client. The model is particularly suitable for structuring a course with external collaboration and user involvement in the development of solutions [21].

The capacity for innovative service design is another challenge that researchers and practitioners are facing today. In fact, the lack of frameworks capable of supporting the innovative service design has already been raised by some authors [22, 18, 23]. The framework called the Service Model Innovation Framework (ServiceMIF) for the design of innovative services described by Fung and Berre [22] proposes customer value development that comprises five milestones: discovery of supplier-customer context, solicitation, evaluation and capture of the customer value (or profit), and finally translating the new version of the service. However, the deep analysis of the user and the service UX is neglected in ServiceMIF. Patrício et al. [23] propose another framework, called Multilevel Design Service (MSD), for the design of complex service systems at three abstraction levels (i.e. value constellation, service experience and service encounter). Despite the detailed level of the proposed models based on the blueprinting approach, the characterization of the service UX remains unclear in terms of evaluating the perception of the user (or customer).

From the user perspective, some studies pointed out that involving users in service co-production may be necessary is some cases [24, 25]. As mentioned by Clatworthy [25], the service design also aims to "ensure that the overall experience of service is useful, usable and desirable as well as efficient, effective and technically feasible". This has given the birth to user experience design

(UXD), which has recently gained significant popularity within the service design community.

2.2 UX Design: Definition and Models

In The scientific literature provides several definitions for the UX concept. The International Standard Organization (ISO) defines UX as a "person's perceptions and responses that result from the use or anticipated use of a product, system or service" [9]. Hassenzahl [26] defines UX at two levels. At the lowest level, he describes UX in terms of actions: motor-goals (e.g. pressing the keys of a cellphone) performed in order to accomplish a do-goal (e.g. sending a text message). At the highest level, UX is detailed as be-goals which motivate the actions. For Law et al.[27], UX includes only the interaction between a person and something that has a user interface. They also argue that UX is subjective and focuses on use, whereas usability is more objective and quantifiable.

Several abstract models characterizing UX have been proposed in the literature. For example, Mahlke [28] describes a UX process model and introduces four dimensions to experience modelling: perceived usefulness, ease of use, hedonic quality, and visual attractiveness. It is claimed that these four factors could explain approximately 79% of the total variance of the intention to use a website. Burmester et al. [29] have described the valence method witch intended to capture positive and negative feelings during the exploration of an interactive product (or service) and elicit the product design aspects causing negative or positive UX. Pallot and Pawar [30] have described a holistic model of UX based on co-creation value with an experimental study for Living Lab experiential design.

Diverse tools for capturing and modeling UX have been proposed. UX-Modeler [31] models the UX using the persona and design patterns. The persona is a narrative description of a class of users that may be involved in the service organization and that has an important role in making different decisions, such as in crisis management [32]. Moreover, Idoughi et al. [33] demonstrated that a persona could be an effective and efficient tool for capturing the main facets of UX.

2.3 Touchpoints as a Technique for Understanding and Documenting UX

In marketing research, extensive work has been done on the importance of the points of contact of the services (called touchpoints) in creating positive effects on customer experience. Iacobucci and Calder [34] describe integrated marketing as a combination of three elements that are closely related to service design: an understanding of consumer behavior, focus on brand and link to customer experience.

In the same way, Baxendale et al. [35] suggest that the coordination of touchpoints is one major part of linking contact experiences to the brand. Other authors have investigated the combination of touchpoint alignment within integrated marketing [36]. Moreover, according to Payne and Frow [37], the touchpoint alignment means that customer contact channels, such as email, in-

store, online, and smartphone channels, are both integrated and available in real time to anyone in an organization of services. Nasution et al. [38] propose a customer experience framework (CEF) that focuses more on the journey of the customer in experiencing the service. A journey or a cycle is a series of critical encounters that take place over time and across channels [39].

The concept of designing touchpoints between the service provider and the customers has recently gained significant credibility in service design. These touchpoints have even become one of the three pillars of service design (i.e. users, content and context) [40]. According to the community of practitioners, service design is "design for experiences that happen over time and across different touchpoints" [41]. This definition confirms the central role played by touchpoints when describing the link between the service provider and the customer through customer experience. However, as mentioned by Howard [42] and Clatworthy [25], there is still little or no documented research work on the applicability and the implementation of this concept in actual service design.

2.4 The Need for an Integrative UX Design and Touchpoint Analysis Framework

Although much literature covers the importance of touchpoint analysis for service design [37, 43], there is little or no documented research on touchpoints when it comes to planning and implementation in the development of new products and services [42]. Furthermore, despite all research conducted on UX design, there still remains the lack of a rigorous service design methodology employing the UX to assist designers in the development of new design service-based solutions. This raises the pertinent research question of how to assist designers in developing a successful service UX? This is a particularly motivating issue in the current research work.

3 UXD-IS: User Experience Design of Interactions and Services Framework

In order to The Figure 1 portrays the key milestones of the UXD-IS framework. The principle of the framework gradually generates artifacts describing all of the aspects of UX (i.e. service context, user characteristics and service touchpoints). The underlying methodology of UXD-IS distinguishes four phases: (1) service context discovery, (2) UX characterization, (3) touchpoint analysis, and (4) service-UX prototyping. Each phase produces an artifact that can be considered by the designer during the next step in the service design process as proposed in the Double Diamond model [21]. The phases of UXD-IS can also be re-executed for improving the UX of service designed.

Phase 1 aims to discover the context in which the service is or will be used, including the technological, human and organizational aspects. This allows designers to understand the activities and human processes supported by the service and the role of each user in these processes.
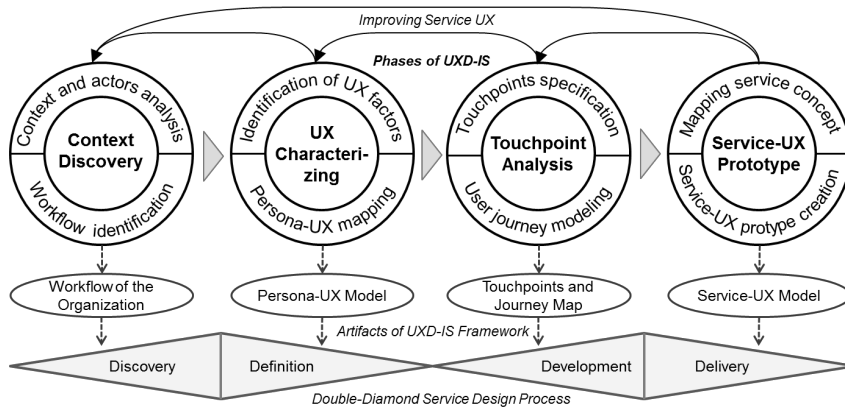
Fig. 1. Overview of UXD-IS Framework

In this phase, the following information is collected:
(1) The definition and the scope of the problem to be solved;
(2) The main activities carried out within the organization to achieve its goals;
(3) The physical and social environment.

Phase 2 consists of studying the users of the service and their experiences. This allows designers to define a set of design goals that can be used during the service development phase. Thus, the designers can assess the service design against this set of design goals. In this stage, we extended the persona technique [15] to support the identification of the relevant UX parameters at earlier phases of the persona creation process. Figure 2 shows the flow chart of the UX characterizing process with persona technique.

The first step aims to collect a mass information on services' organization and future users through questionnaires to target a user group. Based on the information gathered from participants, the nature of the application domain and the organizational documentation, we state preliminary hypotheses about possible personas to be created as recommended in [44]. In the next step we identify the influent UX factors based on gathered qualitative data applying the appropriate UX model, for example a pragmatic-hedonic model [26] or Components of User Experience [28].

The clustering data can be then performed based on preliminary hypotheses and the identified UX factors. After the clustering, we check if users' segments set correspond to the initial hypotheses. Indeed, the hypotheses on the personas can be reviewed if the number of segments and the attributes of the UX obtained for each segment are different. In addition, the designer can compare between different segmentations by applying different clustering algorithms. The obtained segments will be subjected to a second verification in terms of completeness and redundancy. In the next step, each segment will be represented as a persona with its priority (primary, secondary...). In the following stages of the persona creation process, the designers complete the personas with usage scenarios, fictitious

information and finally communicate them to the rest of the design project team. In phase 3, the UX analysis will continue with a service touchpoint and user journey map. The aim of this analysis is to assist designers in the specification of identified touchpoints and modeling of user journey with its UX evaluation.
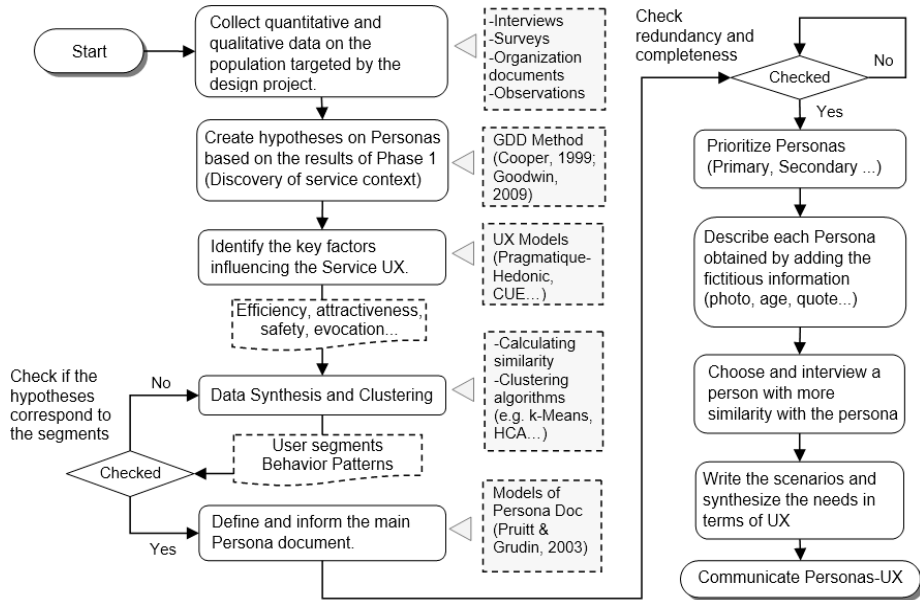

Fig. 2. Flow chart of personas creation enriched with UX factors

During phase 4, a prototype of the service UX is developed based on the results of the three previous phases of the UXD-IS framework. This prototype encompasses the mapping service concept-UX and the modeling of the users' interactions with the service through the list of touchpoints. The prototype, named the Service-UX model, depicts a holistic view of how UX is supported.

4   Description and application of UXD-IS in Crisis Management Case Study

UXD-IS has been applied in the context of a civil protection department (CPD). The aim was to explore the applicability of UXD-IS in the service design loop of current services. We also explored how it helps service designers to create experiences-based services that are more meaningful for emergency responders. A large pool of CPD members and stakeholders has been engaged in the different phases of the proposed framework.

4.1 Description of the Case Study

The case study deals with the center of operations for crisis response and management. The study lasted two months, during which we investigated the structure of the center of operations organization and the tools used for crisis management. A scenario was jointly elaborated with officers and managers of the center of operations, describing the key actions carried out by all of the actors of the center who handle floods. We focused mainly on interactions between the user and the service, as well as those between the different human actors at the civil protection department in their interactions with the existing web-based services.

A total of 24 civil protection agents participated in the study. The participants were divided into two groups, A and B, based on their roles. Group A had 6 participants with the following roles:
• Supervising and coordinating the various actions carried out by all of the civil protection agents.
• Coordinating the operations.

Group B was composed of 18 participants who were in charge of:
• Executing the evacuation and helping the victims during and after the disaster,
• Collecting information about users (i.e. agents of civil protection) and their service experiences.

The participants answered an online questionnaire which provided answers to the research questions: (1) Who are the users of crisis management services? (2) What are their needs and experiences? (3) How well are those needs currently being met?

The questionnaire included 25 questions divided into four sections: demographics (6), scenarios of use related to crisis management services (5), perceptions of crisis management services (7), and experience evaluation (7).

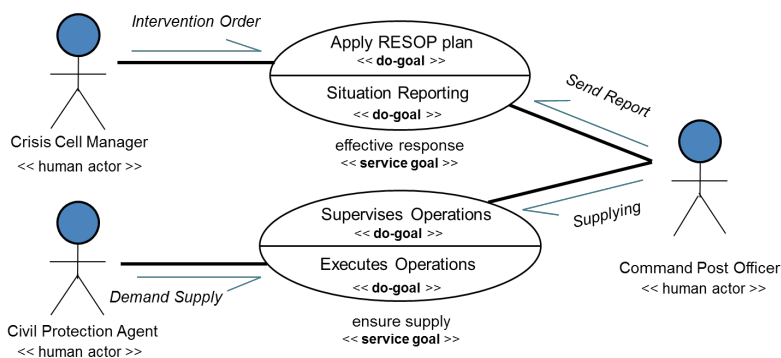## 4.2 Phase 1: Service Context Discovery

Fig. 3. Example of collaboration in crisis management

This phase consists of collecting and analyzing information related to the domain where the service is to be developed (or modified), the environment of the

organization as well as the human actors involved. The tasks carried out by the actors and the underlying information exchanged are documented in a workflow model. The service context discovery enables us to identify the potential actors, their collaboration, and their roles in the service organization. This phase consists of two sub-steps.

Step 1: Context and actors' role analysis.

In this step, apart from questionnaires, we also use interviews and focus groups [45]. To document the collaboration between the different actors, we proposed a graphical notation that illustrates the relationships between actors with their task oriented goals (i.e. do-goal) and activity oriented goals (i.e. service goal). An example of collaboration between three actors (crisis cell manager, command post officer, and civil protection agent) is shown in Figure 3. The crisis cell manager coordinates response operations with the command post officer in order to apply the Rescue Organization Plan (RESOP). The command post officer supervises the intervention operations while ensuring the human and material resource supply of the civil protection agents.

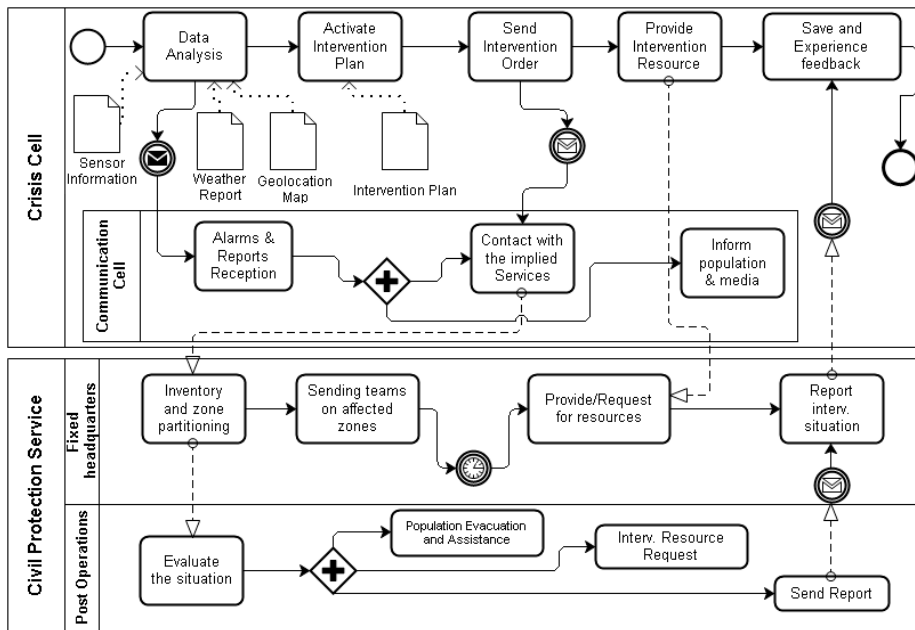## Step 2: Workflow identification.

Fig. 4. Workflow of organization of crisis management services

This step consists of identifying the sequence of activities carried out by the various implied actors. We use Business Process Management Notation (BPMN) [46] to describe the workflow graphically. The aim is to represent the activities, which can be processes, sub-processes or elementary tasks. All of the workflow

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activities are organized in boxes representing parts of the process carried out by a participant (actor or particular organizational entity). Figure 4 illustrates a simplified model workflow describing the sequence of the main activities undertaken by the various actors involved in the CPD organization.

As showed in Figure 4, the workflow model depicts two main business processes (related to crisis cell and civil protection services) wherein different actors interact with the service functionalities. The execution of the workflow starts with data analysis on the crisis situation which can lead to sending an intervention order. After sending the intervention order, the main rescue activities, such as zone partitioning and resource management, are initiated by officers of the fixed headquarters and carried out by agents of the post-operations. The next step concerns the characterization of the actors who will be the future users of the services to be designed.

4.3 Phase 2: Service Context Discovery

The aim of the second phase is to identify the classes of the potential users of the service. These classes must be differentiated using the specificity of the experience of each user class. The persona [15] is thus used in order to characterize the UX for each actor type involved in the services. In addition, the attributes characterizing the UX are defined in this phase and will be allocated to each persona created.

Step 1: Persona and UX attributes identification.

In this step, we use personas to provide an understanding of the service usage in terms of users' characteristics, needs and goals that can be used to design and implement different service features. Table 1 summarizes the activities to create personas associated with the UX attributes.

In this study, the preliminary hypotheses are based on the role played by each actors of crisis management. We use thereby the two identified user categories (i.e. command post officers and civil protection agents) to create the personas.

To identify the significant UX attributes, we have developed an online questionnaire (see Figure 5). In this questionnaire, we proposed items based on the UX attributes cited in several research papers [47, 28].

Then the participant has the choice to evaluate his degree of agreement or to ignore the item. As a result, we obtain a list of UX attributes selected by all survey participants with the score obtained for each attribute. In the case where the NA (Non-Applicable) choice is selected, the attribute will be ignored during the touchpoints analysis (i.e. phase 3). The retained list of UX attributes for the study is shown in Table 3.

To identify the behavior patterns, we observed during the survey that the behavioral aspects such as orientation towards the sense of organization and coordination, level of stress, and the quality of contact with the others are attributes that characterize the UX of each participants group in the study (i.e. groups A and B). For instance, we observed that the level of engagement, utility and clarity in the crisis response process is characteristic of the command post officers (group A). In addition, the UX attributes related to effectiveness,

relatedness and assistance are characteristic of the intervention agents (group B). Therefore, we identified two behavioral patterns which are potentially shared by the participants in each group. In fact, these two patterns represent the two primary personas for this study. Afterwards, we completed the created personas by developing the scenario of use and fictitious information (e.g. photo, name, age, etc.).

Table 1. Description of the persona-UX technique activities

Activities	Objectives	Techniques/tools
1: State hypotheses	State preliminary hypotheses about the possible personas to be created.	Based on the data gathered from the service's users, the nature of the application domain and the service organizational domain.
2: Identify the UX attributes	Based on a list of persona hypotheses, investigate possible UX attributes that influence user-service interaction.	- The interview of class users represented by each supposed persona; - Observation in-situ of users.
3: Identify behavior patterns	- Based on interview responses and selected UX attributes, identify similarities between users' responses with each rang of UX attributes; - Map the respondents to different ranges of identified UX attributes; - Create with the behavior patterns according to the groups of UX attributes.	- Brainstorming and participatory meeting with respondents (i.e. users); - Analyses and syntheses of transcribed interviews; - Clustering and group percentage table (similarity between interviews and rang of the UX attributes).
4: Scenario development	- Write a description of each scene (activities, tasks) of user-service interaction according to persona goals.	- Narrative description, survey, and observation.

Step 2: Personas - UX mapping

In this step, we associate each created persona with its UX attributes identified in the previous step. Based on Hassenzahl's model [25, 47] two categories of parameters should be specified: (1) pragmatic (or instrumental) that refers to usability aspects (e.g. effectiveness, efficiency, safety, learnability, and utility) and (2) hedonic (or non-instrumental) related to the user's perceptions (e.g. pleasure, autonomy, competences, and sociability).

The proposed persona-UX model consists of two main parts (see Figure 6.b). The first part uses a traditional template of a persona (i.e. scenario of use, goals and expectations, and disabilities) as presented by Pruitt and Adlin [16]. The second part is relative to the UX evaluation aspect of the existing service. Each element of the service (e.g. home page, research engine, etc.) is evaluated against both pragmatic (usability) and hedonic attributes using UX assessment models [45, 48] like an online questionnaire with evaluation scales. This allows a service designer to have a richer view on the perceived service UX quality.

Indeed, the quality of the UX has been evaluated according to the three aspects of the service concept: content, interaction and functions [39]. For each aspect, we have chosen specific elements of the service (e.g. home page, map viewer) and assessed the quality of the UX perceived by the user at each encounter with those elements. To perform this assessment, we use self-reported metrics [48]. This approach aims to give the most important information about the users' perception of the service and their interaction with the service.

To collect self-reported data, we use a rating scale based on the seven-point scale (i.e. disagree-agree). Therefore, an online questionnaire has been provided for each participant to transcribe the degree of the UX perceived during his interaction with service element. Measured by Cronbach's Alpha, the results of this study showed the scales were sufficiently reliable. The Figure 5 illustrates the questionnaire with a sample evaluation of UX.

Fig. 5. The questionnaire to identify and evaluate the UX of crisis management services

We reported hereafter some results of the UX evaluation. Figure 6 shows the results of the UX quality evaluation (vertical axis) for sequence activities (horizontal axis) reported in the scenario of the case study related to operations intervention. For clarity, we chose only three UX attributes (i.e. effectiveness, trust and satisfaction).
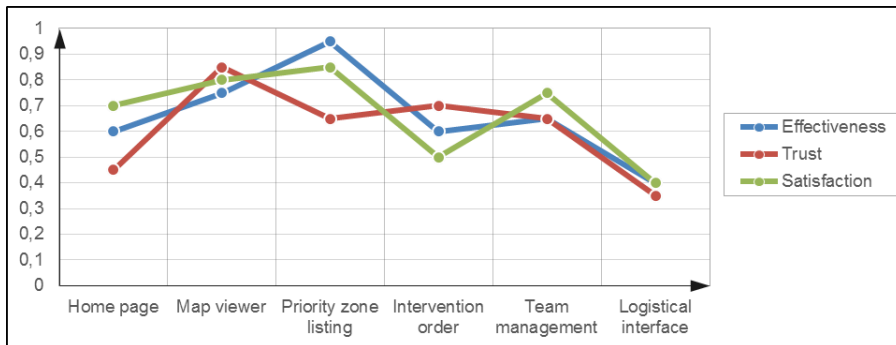
Fig. 6. Results of the UX evaluation related to the scenario of the operations intervention

The Table 2 shows the detailed list of UX attributes related to persona "Command Post Officer" with the average values of UX quality for each factor.

Table 2. UX Attributes evaluation

Service aspect	Service element	Instrumental (Usability)			Non-Instrumental (Hedonic)			
		Effectiveness	Safety	Utility	Trust	Engaging	Satisfaction	Confidence
Content	Home page	0.60	0.55	0.75	0.45	0.65	0.75	0.65
	Priority zone listing	0.95	0.80	0.90	0.65	0.70	0.85	0.80
Interaction	Map viewer	0.75	0.65	0.80	0.85	0.90	0.80	0.75
	Logistical interface	0.40	0.35	0.40	0.35	0.50	0.40	0.35
functions	Teams management	0.65	0.70	0.75	0.65	0.55	0.75	0.60
	Intervention order	0.60	0.55	0.65	0.70	0.45	0.50	0.55

As shown in Figure 6, the effectiveness factor related to usability quality is more significant than the satisfaction factor when the users interact with the priority zone listing interface. This proves a correlation between some usability attributes (e.g., effectiveness and utility) and hedonic attributes related to the general perception of the UX. However, this is not always valid with the affection attributes (trust and engagement) that depend on the internal state of the user, as mentioned by Hassenzahl et al. [47]. Therefore, it is necessary for the designers to keep in mind the overall result of the UX evaluation to revise some design elements, especially when the users interact with a succession of service touchpoints. To this end, a depth analysis of service touchpoints is necessary to improving the UX of the designed service.

To support the design of Persona-UX model, we have developed an application called Persona-UX Design Tool. The Figure 7 shows two screenshots of the tool. The first depicts the clustering component for creating the personas

based on behavior patterns. The second screenshot shows the viewer of Persona-UX model.
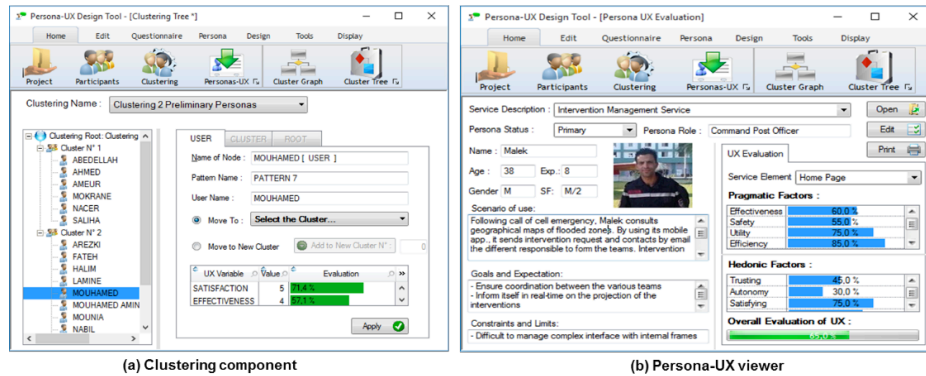

Fig. 7. Persona-UX Design Tool as support tool binding UX evaluation and Persona

4.4 Phase 3: Touchpoints Analysis

Different interaction interfaces between the implied actors and the services are identified in this phase. Each of these touchpoints is specified in terms of interactions that have occurred, the resources and the communication channels used, and the exchanged information contents. Consequently, a diagram representing the contact points of the service is given at the end of this phase. This phase is conducted through two main steps as follows.

Step 1: Touchpoints specification.

Table 3. Touchpoints with UX characterization

Touchpoints	Service resources		UX attributes		
	Channel	Terminal	Usability	Hedonic	Consequence
Web site	Internet	Computer, smartphone, tablet.	Effectiveness, efficiency, safety, utility, clarity, learnability, memorability.	Positive UX : confidence, simplicity, assistance, engagement, comfort, stimulation.	- Motivation
Map mobile application	Internet, GPS, WIFI, GPRS.	Telephone, smartphone, tablet.			- Satisfaction - Appeal - Competence -Emotional achievement
Intervention management system	LAN, Internet.	Computer, smartphone, tablet.			- Attachment - Acceptance of challenges - Experience - Sociability.
Call center	Phone line	Telephone		Negative UX : annoyance, unpredictability, frustration, complexity, unhelpfulness, dullness.	
Mail service	Internet, phone line	Computer, smartphone, tablet.			

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We explore the results obtained in Phase 1, in particular the workflow model and its components, to identify the list of the service touchpoints. However, complementary information is necessary to draw up a complete listing of the service touchpoints. Thus, some interviews must be conducted with the user of the service, and some documents of the organization must be consulted, such as customer relationship files and log files about user activity. Table 3 shows the list of touchpoints with their service resources (i.e. channel and terminal) and UX attributes related to the "Command Post Officer" persona.

Next, we specify the connections between the identified touchpoints and the potential activities supported by the service. The result of this assembly is a touchpoint matrix. The lines represent the service touchpoints and the columns activities involved in the service experience creation. Thus, if an activity includes the interaction at the touchpoint level, a small circle is positioned at the intersection of the activity line and the touchpoint line. Each circle represents a connection point for the user in the overall service experience. In addition, the designer can associate for each touchpoint the appropriate list of UX attributes (e.g. confidence, engagement and satisfaction) represented by a code (Ui). This list allows us to evaluate the UX quality at a specific interaction moment of the user with a specific touchpoint, and simplify and clarify the obtained matrix.

The touchpoint matrix is used to provide a visual schema that enables a service designer to connect the points of contact in the user experience. Once the touchpoint matrix has been created, the service designer can connect it to a specific persona and draws its journey, detailing the different touchpoints. Thus, the touchpoint matrix brings a deeper comprehension of the user-service interaction and facilitates the further development of the opportunities offered by the service.
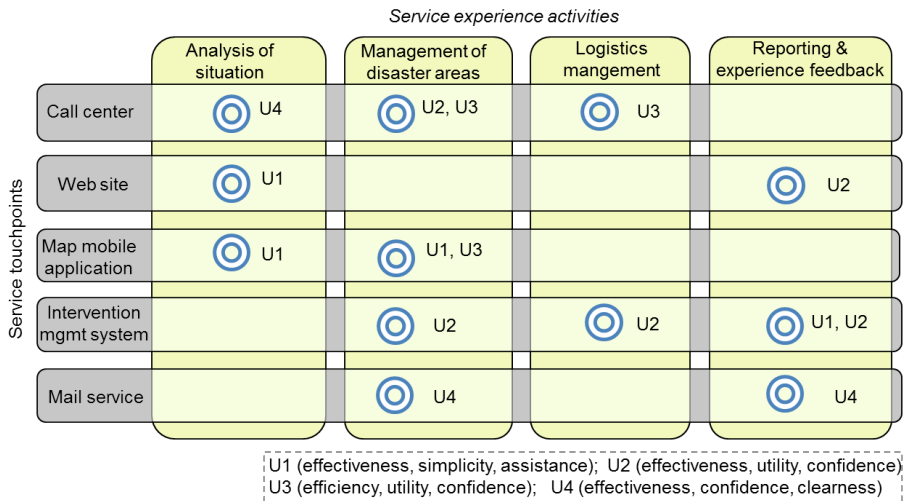

Fig. 8. Touchpoint matrix for a crisis management scenario

Finally, the graph of the touchpoint matrix provides a quick visualization of what is possible in terms of interaction with the different touchpoints.

Subsequently, the introduction of the personas drives the representation of several specific journeys within the graph and the comprehension of the possible derived user scenarios. Figure 8 depicts the touchpoint matrix related to the intervention management scenario.

As shown in Figure 8, each point relates to a touchpoint and a specific service experience activity characterized through a common set of UX attributes (Ui). For instance, according to the user study (i.e. Phase 2) the actors in the operations' post believe that the current mobile application related to crisis area management should have a simple user interface with suitable assistance features. Moreover, the confidence aspect of the communication with the crisis cell team remains an important issue for the staff of operations' post. The study shows also that the list U4 (i.e., effectiveness, confidence, and clarity) is crucial in the assessment of the quality of UX in both the management of disaster areas and feedback reporting.

Step 2: User journey modeling.

At this step, the focus is on the description of the entire life cycle related to the interactions between the user and the service touchpoints. It is thus a question of tracing the interaction points shaping the overall service experience. In other words, we start from information on the personas, the selected touchpoints, and the scenarios of use. These scenarios scrupulously describe the moments, events and scenes that occurred at the time of the meeting of the user with the service.

This step synthesizes the entire journey of a persona in a unified written form. Indeed, it is a question of superimposing the persona's journey experience on the touchpoints used and the potential activities carried out during the service experience. The result is a diagram called the user-journey map that illustrates the journey of each persona with the service. This type of diagram is represented as a directed graph, where the nodes represent connections between the activities of the persona and the touchpoints of the service, and the arcs illustrate the sequence at the time of the encounter between the persona and the service. This conceptual visual representation is useful for designers in pinpointing the best user-service interaction moments and the "pain points" that need to be improved or eliminated.

Finally, including the user journey map in service design process have the following advantages:
• Identifying the pain points (e.g. confusion, conflicts, misunderstanding, and irritation) that do not perform particularly well from a user viewpoint when interacting with the service. For example by identifying in a web page the link where interaction with service is interrupted, or an action to which the user reacts negatively;
• Adding new touchpoints to the user journey or modifying and improving some touchpoints of the user journey to improve the UX;
• Mapping an existing situation by identifying the service touchpoints that are relevant in each phase of the user journey;
• By studying the user journey diagram, the designer of the service can anticipate the following phase of the service encounter;
• Proposing to the user the best possible journey to achieve the objectives of the service interaction.

Figure 9 shows an example of a user journey schema related to the persona

created in the case study. This schema traces the whole of encounters between the persona "Command Post Officer" and the various interfaces of the "Intervention Operations Management Service". In addition, based on the results of Phases 1 and 2, we can identify exactly the task implied in the persona-touchpoint interaction.

The user journey schema presented in Figure 9 shows that only some points (with red color) in the touchpoints matrix were involved in the journey. Otherwise, we linked only the points related to the user-service encounters described in the scenario of the persona concerned. In this user journey schema, the introduction of the persona 'Malek' allows the representation of several specific journeys within the graph.

To assess the UX quality of the journey, each encounter of a persona with a given touchpoint is rated by the participant group using a quality degree. For this, we apply a five-point scale, as in Phase 2. Each valuated UX factor group (i.e. U_i) defined in step 1) is represented using a column of values next to the persona-touchpoint interaction point (Figure 9). As depicted in the user journey schema (Figure 9), we observe a decrease in UX quality during the interaction between the persona 'Malek' and 'Intervention Management System' touchpoint, particularly when 'Malek' edits and sends the 'Resources Request'. Indeed, the factor values of U2 (i.e. effectiveness: 0.4, utility: 0.4, and confidence: 0.3) show a low usability quality for the 'Logistic Management' service interface. This indicates that users did not like the experience proposed by the logistical management service interface.
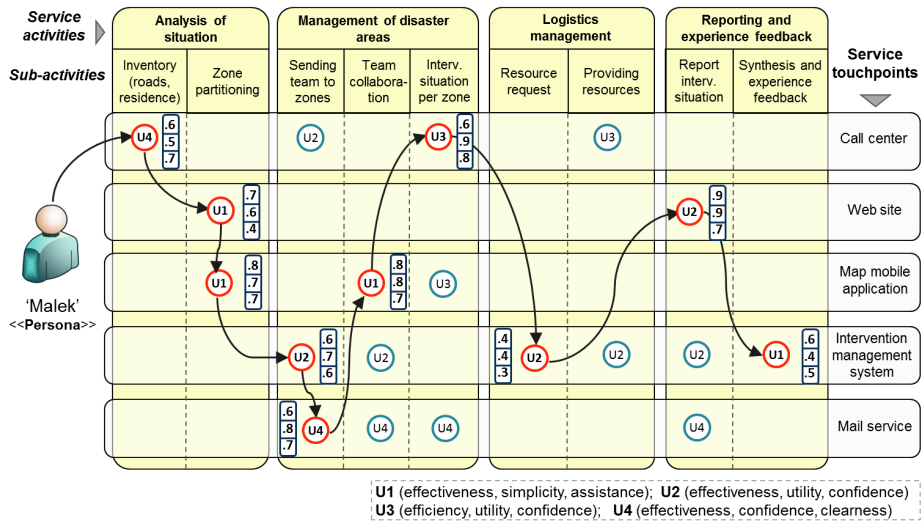

Fig. 9. User-journey schema for the persona "Command Post Officer"

Therefore, when redesigning the interface concerned, the designers must consider usability attributes such as effectiveness and utility by, for instance, reduce the number of user' actions when editing and sending the request. In

addition, the designers can ask the participants to give more information about their experiences with such a service touchpoint. This may give more details about the problems that current users have faced while interacting with the touchpoint in question.

Finally, with the user journey schema, the designer can deduce the possible user scenarios enabling the enhancement of the UX quality across selected touchpoints. To do this, the designer can determine the user journey that accumulates a higher score for UX quality when connecting the appropriated existing touchpoints, or in some cases add new touchpoints. To this end, it is necessary to analyze in depth the overall service UX components; this is the goal of the next phase.

4.5 Phase 4: Service UX Prototyping

In this phase, a synthesis is carried out on the models obtained from previous phases to highlight and describe all of the elements constituting the service experience and their interrelations. This consists of defining a cartography unifying at the same time the service concepts (described by the workflows and touchpoints) and the UX characteristics (described by the personas and user journey). This may serve as a work support for the service designers, and to facilitate its exploitation, the service blueprinting model [17] and an extended BPMN notation [46] are used. This phase is conducted through two main steps as follows.

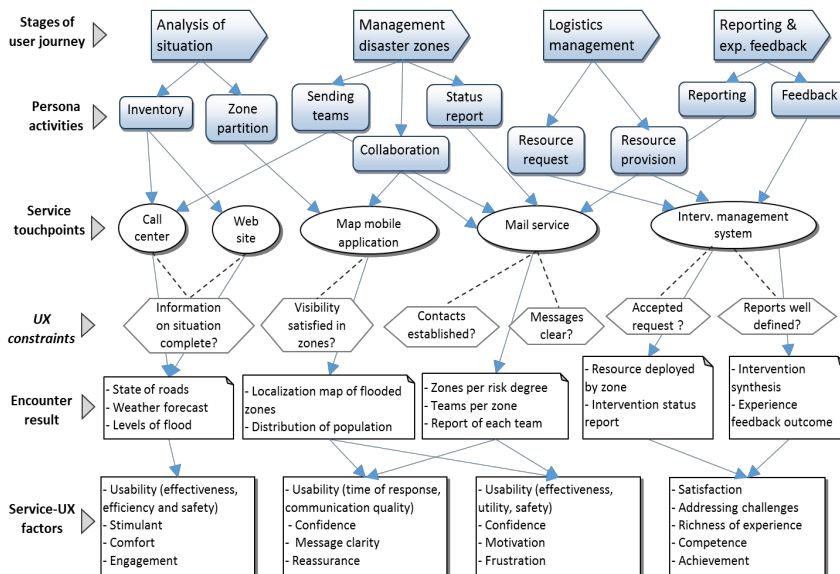### Step 1: Mapping a Service concept and UX.

Fig. 10. Hierarchical analysis of service-UX components

In this step, each activity must be related to one service touchpoint or more. The progress of these activities through the user journey makes it possible to generate results (or artifacts) which finally determine the service value perceived by the user. In addition, each persona-touchpoint encounter creates a user perception (i.e. consequences, emotions, and judgments) about the service UX quality. These perceptions are gathered in the form of a set of attributes that are used to measure the generated UX quality.

To carry out this type of analysis, we define a graphical tree structure, highlighting the relations maintained between the various components of the user journey and divided into six levels (see Fig. 10). At the first level, the main phases of the user journey are linked with the corresponding activities according to the scenario described in the persona. At the following level, a list of touchpoints involved in the execution of the activities is established. At the fourth level, we specify UX constraints, checking the UX quality of the encounter between the persona and touchpoint. As a result, we obtained the relevant information that enables measuring the value of the service. At the last level, we specify the service-UX attributes that allow us to evaluate the perceived UX quality at each touchpoint.

Figure 10 presents an illustrative example describing the hierarchical analysis of service-UX components relating to the "Intervention Operations Management Service".

As already highlighted in the touchpoint matrix, four stages are identified in a user journey related to the service experience. For instance, the activity "team sending" that is included in the "management disaster zone" requires two service touchpoints (i.e. call center and mail service). For the "mail service" touchpoint, it is important for the officer to verify if the contacts were well established with the agents' team, and verify the clearness of message received from the agents present in the flooded zone. Once those constraints were satisfied, the officer may obtain the result of the service encounter (e.g. list of teams per zone and intervention report). Finally, each encounter was characterized through UX attributes related to both usability (e.g. utility and safety) and hedonic attributes (e.g. confidence and motivation). Such characterizations of the persona-touchpoint encounter may provide for the designers a rich holistic understanding of the service UX.

Step 2: Service-UX Prototype Creation.

This last step consists of building a model for taking into account the UX in a service design process. This model encompasses the artifacts resulting from the previous phases, articulating them in a unified diagram. This model will provide a precise and detailed view of the user-service interaction process to achieve the user's objectives. Moreover, this model helps better to understand the service UX creation process and the impact the user journey has on the generated service UX quality.

The Service-UX Card artifact consolidates and combines different design models which are workflow, the persona model and the user journey map obtained from the previous phases of the framework in order to build a new version prototype of the service-UX.

To build this prototype, an extension to the BPMN notation was necessary. we

have integrated three new elements into the BPMN notation to better support the integration process of the UX in service design. These new elements help to

1) Visualize explicitly the significant encounters that shape the service UX. Thus, we propose to include in the BPMN formalism the vertical representations illustrating the important moments that have occurred at the time of the interaction between the user and the service. Indeed, each representation details a phase in the user journey for the created persona.

2) Differentiate between the actors. This distinguishes representing the users of the service (external or internal users of the organization) and representing the service touchpoints. We propose to separate the two types of elements (personas and touchpoints) by distinctive horizontal BPMN swim lane symbols. Two distinct symbols are assigned for this purpose.

3) Including the interaction lines between personas and service touchpoints. We propose to use the interaction lines, according to the blueprinting model [17], to separate the service users from the various supports (systems or physics).

Table 4 illustrates the added symbols of the tree elements.

Table 4. Elements for an extended BPMN notation

Graphical form	Description
<Name of Persona>	A symbol indicating a persona. The name of the persona must be indicated. The role of the persona can be also specified. Each persona is associated with a pool structure in a BPMN model.
< Touchpoint name>	A symbol indicating a specific service touchpoint. Each touchpoint must be associated with a pool structure in a BPMN model.
<UX purpose>	A symbol specifying an important phase in the user journey for the persona. A vertically aligned corridor is associated in a BPMN model for each phase of the journey.

Figure 11 illustrates an example of the prototype of the Service-UX Card related to the intervention management in the operations' post.

As shown in Figure 11, the persona named Malek starts his user journey with an analysis of the situation in the flooded region by requesting more information about the geographical position and alert reports received from the crisis cell. Malek then interacts with different features offered by the service organization to achieve the required operations of the intervention management process. For instance, officer Malek can firstly send a supply resource request to the protection civil center or crisis cell by using the call center touchpoint. Next, he saves the request by using the touchpoint of the intervention management system.

The prototype of the Service-UX Card presented in Figure 11 clearly shows the distinction between the activities performed by the persona Malek and the backphase tasks carried out at the level of service touchpoints. This distinction is specified through the drawn interaction line. As a result, the Service-UX Card can

help a service provider better to understand how its services are "consumed" by their future users, and, in so doing, be able to refine and optimize each touchpoint along the user journey schema described in Phase 3.
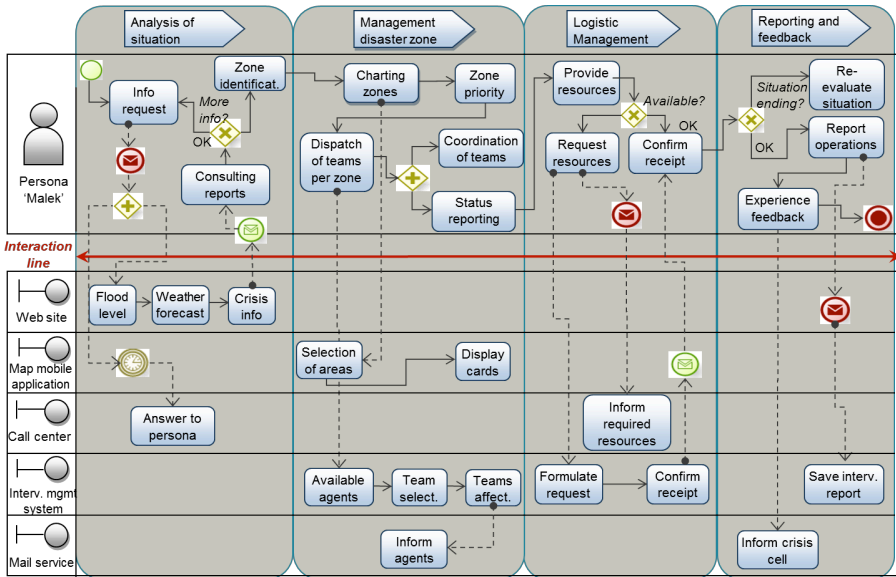

Fig. 11. Service-UX Card

5 Evaluation

The UXD-IS framework has been developed and applied to the design of crisis management services. We also compared the framework with two existing frameworks: ServiceMIF [22] and MSD [23]. In the ServiceMIF framework, the touchpoint analysis uses a reduced model that directly links every service touchpoint with a channel and an activity. In contrast, for a given activity in the UXD-IS Framework, the user may have several choices in the touchpoints and channels to use. This gives more flexibility to designers in selecting the most relevant journeys to improve the UX quality perceived by the end-user.

Moreover, the UX evaluation approach used in ServiceMIF is based solely on the overall UX assessed on a very basic scale (bad, good, excellent) without considering the components and the complexity of the UX concept, particularly distinguishing between instrumental attributes and hedonic attributes of the UX. Therefore, it makes the process of ideation and innovation for designers more vague and rigorous in the selection of service design features. The UXD-IS framework solves this problem by exploiting the UX characterization models that exist in the literature, such as those introduced by Hassenzahl [26] and Mahlke [28], to analyze in depth the facets of the UX generated during the use of the service and thus enables a more refined and accurate assessment.

For the MSD framework [23], despite the detailed models it generates, the analysis model of the service experience at the touchpoints (i.e. service encounter level) remains static because it can describe the experience of a single type of user (i.e. the customer) with only one possible journey. Therefore, on the one hand, this excludes the integration of different categories of users. On the other hand, the evaluation of the UX quality and comparative analysis between several user journeys becomes impossible. This problem is mainly due to the lack of studies of users' archetypes and their intrinsic characteristics and behavior.

In response to the issues previously raised in MSD, the UXD-IS framework has proposed integrating the persona model into earlier phases of the service design life cycle. This helps to develop adaptive and configurable services for each user category, represented by the persona, and to anticipate new needs of users that may contribute to improving the quality of the service experience.

To validate the UXD-IS framework, relevant artifacts obtained during the implementation of the framework (workflow, persona-UX, touchpoint, user journey and UX-Service Card) were proposed to a team of four designers specializing in mobile application development. This team uses these artifacts to develop new ideas and possible improvements to the service design.

Table 5 shows the expertise level for each participant (identified by D1, D2, D3 and D4) both in their professional field and the Service UX Design.

Table 5. Expertise level of participants

Designer	Professional field			Service-UX Design knowledge	
	Role	**Domain**	**Level**	**UX**	**Service Design**
D1	Developer	Mobile applications development for public services	Medium	None	Limited
D2	Developer		Medium	basic	Medium
D3	Architect		High	basic	High
D4	Manager		Expert	Medium	High

Initially, we trained the designers in service design principles and the UX concept while presenting them the proposed framework and the five design artifact results obtained in the case study. We allocated two weeks for the designers to apply the framework. Subsequently, a reflection meeting and discussion with the participating team were organized at the end of the framework implementation.

We conducted at the end of the evaluation period two brainstorming sessions with the four designers. We used during these sessions paper supports to transcribe their opinions and a tape recorder to record the responses of each participant to the evaluation of the proposed framework.

Finally, we organized the collected comments according four themes: (1) collected personas in the analysis' needs, (2) the impact of UX attributes on service design, (3) concerns of the involvement of the touchpoints and the user journey in the creation and adjustment of some features of the service, and (4) addressing the use of the UX-Service schema in the design of innovative user-

service interactions.

Table 6 summarizes the feedback from four designers on the contribution of the framework to their crisis management service design practices.

Table 6. Expertise level of participants

Theme	ID	Transcribed remarks
Implication of persona	D1	I think that personas are a good way to communicate and exchange new ideas between us developers and even with other participants (stakeholders, users, etc.). However, it is unclear how to use them concretely in the design process.
	D2	The most important part is the *service scenario* where I can use it to deduct the interactions between the user and the elements of service interface; otherwise, I think the demographic information is not useful.
	D3	I do not use personas in the specification needs and analysis step because I am not sure if they reflect reality or not!
	D4	I find that personas are a good tool to focus on the real users of the service rather than on our own inspirations.
UX factor evaluation	D1	I think that the UX attributes related to the usability aspects are objectively verifiable, such as spending time on a specific task; but it is not the case when you address the subjective hedonic attributes, like stimulating and engaging!
	D2	In my opinion, the evaluation of UX quality in the service interface is very useful for determining what the user feels when interacting with some features of the service.
	D3	I think that using the evaluation results of hedonic attributes remains unclear, unlike usability values. Therefore, as a designer, focusing more on UX evaluation can significantly increase the time of service design.
	D4	The linking of service elements with user perceptions in terms UX quality is very interesting when you apply the evaluation test of each service UI mockup.
Touchpoints and user journey	D1	The association of each point of contact (touchpoints) with the UX attributes is in my opinion very useful in the assessment of the existing interface and its improvement.
	D2	The user journey schema seems more practical than the abstract models of UML, which I use to model the flow of users' actions, including sequence and activity diagrams.
	D3	I found that the touchpoints and the connection between them does not provide more compared to traditional UML models like the sequence and activity diagram. Besides, I think it is difficult to transform this model (i.e. user journey) into a more practical service model.
	D4	Evaluation of the UX at every touchpoint is important in my opinion you design a new service interfaces that will be more attractive and easy to use!

	D1	This synthesis model reminds me of business modeling processes, in particular when designing the service orchestration aiming to achieve a common goal.
	D2	The distinction between the user tasks (persona) and service activities facilitates the development of the journey scheme in the graphical service interface.
Service-UX Card	D3	I find that this model is interesting; however, its operation requires some background on the BPMN notation and the *blueprinting* method, which constitutes for me an obstacle!
	D4	I think that this model provided a rich view in terms of the sequence of activities; however, it becomes, in my opinion, more difficult to create it for more complex design problems.

6 Discussion

This research highlighted some interesting research findings which can be discussed from different aspects.

6.1 Service Design Practices

The study performed with the designers' team on applicability of the framework confirmed the benefit of leveraging the UX characterization in a service design process. In fact, the case study conducted in the crisis management field proves that the proposed framework can provide a relevant design support tool through its artifacts. For instance, the use of the persona tool combined with UX attributes enables capturing the most important users' needs, such as their goals, expectations, and context of use (scenario), and most perceptions related to service encounter. Using this support tool (persona-UX) in service design may provide an effective tool for designers to make the right decisions about what the real users expect from a future service.

In addition, the incorporation of the touchpoint matrix and the user journey map in the service design loop can assist the designers in the development of new solutions and ideas about new services, or to enhance the UX quality of an existing service. Precisely, such incorporation leads to improving the usability (e.g. learnability, memorability) of some service user interfaces when identifying poor UX value at a specific touchpoint, or during the user journey evaluation. This improvement may concern adding, modifying or even removing some service touchpoints which have unsatisfying UX quality during the evaluation. Moreover, the Service-UX Card artifact also provides a richer picture of how the user interacts with the service touchpoints and its functionalities. It therefore represents a direct link between the UX design and service development process. Finally, we claim that all those artifacts (persona-UX, touchpoint matrix, user journey map and SUXC) highly promote design thinking [49] in service design practices within the service design discipline.

6.2 Service Usage and Management

Our study confirmed the central role of the end-user in the creation and development of innovative services. In fact, the proposed framework aims to ensure the designers' reactivity facing the changes and the new service user requirements. Indeed, by studying the evolution of the UX quality through the analysis of the UX attributes and user journey map the designer can react in real time by asking the user about his experience with a particular touchpoint or about a specific journey. This may help the users of the service to obtain a better response to their needs in terms of UX. Moreover, by applying the proposed framework, the designer can develop a service that proposes and identifies the best possible journey to improve the UX of the users. In crisis management, it will be interesting to provide the actors involved a list of the best sequences of activities, proposed by the service in order to efficiently respond to the crisis. That will have a positive impact on interventions in real crisis situations.

Developing services by applying the proposed framework can help to control the user journey through different service touchpoints. As a result, for example, a crisis management actor may avoid getting lost during his or her interaction with the service. Therefore, this approach allows create service designs delivering some confidence and insurance to users against the service. Another advantage of applying the proposed framework is prioritizing the provided options and the relevant contents to the users at the right moment. In fact, by using the user journey map and the Service-UX Card, the designer can consider and anticipate the best options and provide the relevant contents to the user at each touchpoint along the user journey.

6.3 User Study: Persona

Despite the limited time allocated to the designers to apply the framework to develop new design solutions, the designers have broadly and easily adopted our approach. However, we noted certain difficulties encountered by the participants, particularly in the use of personas and also in trusting the information transcribed in the personas provided. In fact, that confirms the result of the study undertaken by Friess [50], who noted that the effective use of and empathy generated by the personas are observed much more in the creators of the personas than in other the members who did not take part in the creation of the personas.

However, the credibility problem of personas has already been discussed in [16, 51], who propose rigorous user studies to create personas and linking them to what is called the "foundational document" [16] which includes the user study data backing up the persona. In this study, we had linked each element of a persona with the result of interviews and a survey carried out during the case study. Thereafter, we observed that participants better accepted the personas created.

6.4 UX evaluation

Another issue raised by the participants is that the framework presents very

subjective information to be used directly in the analysis of needs. Participants indicated that overall, the touchpoints and user journey provide more realistic and practical views on different aspects of interaction between the user and the service in accordance with the scenario described in the persona. Furthermore, despite the difficulty encountered by some participants in the use of the new models such as the user journey and UX-Service Card in their design, participants agreed that the artifacts generated or used by the framework help to develop new ideas and especially focus on the real needs of the users.

6.5 Qualitative evaluation criteria

In our case study, we proceeded to define the problem to be solved (i.e. How to take into account the UX facets in the design of crisis management services?). Therefore, we conducted a survey based on a set of research questions to collect qualitative and quantitative data directly related to our research problem. We have selected a representative group of stakeholders in a crisis management structure. However, the reliability of the results of this survey depends on several factors, including the internal and external consistency of the responses and the interpretation of the subjective data collected. To measure the consistency of the responses we evaluated our online questionnaire using the Alpha Cronbach coefficient with an acceptable result (i.e. $\alpha = 0.67$). In addition, we conducted brainstorming sessions to synthesize and interpret the subjective data. On the other hand, we interviewed a representative person of each group of participants represented by a persona in order to describe objectively the persona' characteristics.

In the next step, we submitted the results obtained from the case study to a group of designers for qualitative evaluation of the proposed framework. The goal is to evaluate the impact (positive or negative) of integrating framework phases and related artifacts into interactive services design activities. Our qualitative study with the designers' team revealed the possible transferability of our framework to other areas of application. For example, medical emergency management and e-governance are application fields where human experience factors can contribute significantly in emergence of innovative service designs.

6.6 Limits and suggestions

We recognize that this study presents some limits relating mainly to limited number of participants in the survey. Indeed, the creation of a user model (i.e. Persona-UX) requires the participation of a wide range of users from different sectors in crisis management. In addition, the validation of the approach presents gaps in the limited number of experts and their expertise (i.e. mobile application development). Therefore, we suggest extending this study to other experts including software engineering and service design.

Finally, this study shows that integrating UX in the design and development of services remains a major challenge. Unfortunately, we found that service design seldom focuses on UX modeling and capture. Furthermore, crisis management remains insufficiently explored by the service designer community, particularly

the integration of the UX facets for the possible design evaluation of new or existing services. This research need to focus more on the end-to-end journey of all stakeholders and move away from "polishing" individual touchpoints.

6 Discussion

The proposed UXD-IS framework for the capture and integration of UX into the service design process is a simplified but very helpful way of improving overall service design practices. The analysis of the large existing body of knowledge both on UX and service design techniques paved the road for the UXD-IS framework development and validation. It also justifies why the framework uses diverse techniques to document and model UX. UXD-IS exploits an innovative design process that distinguishes four stages. The framework has been developed, used and validated using a concrete, real-world case study in the field of crisis management services. We conducted an empirical study with a small team of designers in order to understand their perceptions and practices when using the proposed framework. The results show that participants were able to master and use the diverse techniques included in the proposed framework.

An important component of this research is understanding designer activities and how stakeholders can participate in these activities while being engaged in each of the four stages of the proposed process. However, it is important to provide more details of each of the four stages. One issue is then the study of how stakeholders become more engaged and can contribute to these design activities beyond just providing information on their experiences. Another beneficial research focus would be what encourages or inhibits the cooperation of service designers and stakeholders. Studies of computer supported collaborative work could guide designers in attracting and retaining their most loyal stakeholders.

Through this paper we hope advanced the discussion on service design and design studies in the field of crisis management. This includes the different ways in which crisis managers and operators can participate in the design of services. Our proposed framework has been compared to two existing frameworks. Still, it requires more extensive empirical testing, which is the obvious next stage of this work. For example, the persona technique for capturing the various aspects of the UX needs further investigation to convince designers about its utility in crisis management. An extension of the persona-UX model is needed to effectively incorporate in the persona template the relevant empirical data from the user analysis study. In addition, a tool that assists designers in using the proposed framework is required. In the long term, this tool will make it possible for designers to transform the data collected during the analysis phase (scenarios, workflow, attributes, UX, etc.) into a usable service design.

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