A Process Reference Model for UX

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Abstract. We propose a process reference model for UX (UXPRM), which includes a description of the primary UX lifecycle processes within a UX lifecycle and a set of supporting UX methods. The primary UX lifecycle processes are refined into objectives, outcomes and base practices. The supporting UX methods are refined into related techniques, specific objectives and references to the related documentation available in the literature. The contribution of the proposed UXPRM is three-fold: conceptual, as it draws an accurate picture of the UX base practices; practical, as it is intended for both researchers and practitioners and customizable for different organizational settings; methodological, as it supports researchers and practitioners to make informed decisions while selecting UX methods and techniques. This is a first step towards the strategic planning of UX activities.

Keywords: User experience · UX base practice · UX methods · Process reference model · Capability/maturity model · Agile methods

1 Introduction

This paper elaborates on our previous work entitled *Specification of a UX process reference model towards the strategic planning of UX activities* [40] and consolidates it by updating the set of considered references. This work aims at supporting and improving the integration and establishment of UX practice in software organizations. The notable changes from the previous version of this work include:

- The addition of a background section focused on capability/maturity models and their application in the human-computer interaction (HCI) field;
- The adoption of ISO24744 [28] to specify the UXPRM according to software modeling practices;
- The increased level of detail with which the UXPRM is specified (base practices and related references);
- The improvement of the classification of supporting UX methods;
- The perspective of the contribution in relation to the related work.

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2 Background

2.1 Process Reference Model

A process reference model (PRM) describes a set of primary processes and their interrelations within a process lifecycle in terms of process objectives and process outcomes [31]. A primary process is a group of processes that belong to the same category and that are associated with the same objectives. The term process outcomes refers to work products, which are the artifacts associated with the execution of a process. Process reference models are refined into base practices that contribute to the production of work products [31].

Usually, a process reference model is associated with a process assessment model (PAM), which is a measurement structure for the assessment of the capability of organizations to achieve process objectives and to deliver process outcomes consistently [31]. Together, a process reference model and a process assessment model constitute a capability/maturity model.

2.2 Capability/Maturity Model

A capability/maturity model (CMM) formalizes the software development processes and recommends base practices to enhance software development and maintenance capability [67]. Especially, a capability/maturity model serves as a tool to help organizations select process-improvement strategies by determining their current process maturity and identifying the issues most critical to improving their software quality and process [67]. The purpose of such models is to support organizations moving from lower to higher capability/maturity level.

Typically, CMMs include five or six levels that describe the level of capability/maturity of a process (Table 1). Process attributes, which include methods, techniques, tools, base practices, data collection and analysis, goal setting and work products, serve as indicators of the capability/maturity level of processes.

2.3 Capability/Maturity Models in HCI

In HCI, capability/maturity models, which are referred to as usability capability/maturity models (UCMMs) or user experience capability/maturity models (UXCMMs), aim to help software organizations establish user-centered processes in order to improve software quality and increase organizational efficiencies [72,75]. Among the most often cited in the literature, there are Jonathan Earthy's 1998 Usability Maturity Model [18], Eric Schaffer' 2004 model for Institutionalization of Usability [76], and Jakob Nielsen's 2006 model for Corporate Usability Maturity [63]. The two latter have been renamed Institutionalization of UX and Corporate UX Maturity respectively, as a result of the paradigm shift within the HCI community from usability to user experience [40].

Since the late 90s, the International Organization for Standardization (ISO) actively contributes the documentation of UCMMs/UXCMMs.

Table 1. Capability/maturity levels in CMMs.

ISO/IEC 15504 [31]	Software CMM [67]
0. Incomplete: There is general failure to attain the purpose of the process. There are few or no easily identifiable work products or outputs of the process	
1. Achieved: The achievement may not be rigorously planned and tracked	1. Initial: The software process is characterized as ad hoc, and occasionally even chaotic
2. Managed: The process delivers work products according to specified procedures and is planned and tracked	2. Repeatable: Basic project management processes are established to track cost, schedule, and functionality
3. Established: The process is performed and managed using a defined process based upon good software engineering principles	3. Defined: The software process for both management and engineering activities is documented, standardized, and integrated into a standard software process for the organization
4. Predictable: The defined process is performed consistently in practice within defined control limits, to achieve its defined process goals	4. Managed: Detailed measures of the software process and product quality are collected. Both the software process and products are quantitatively understood and controlled
5. Optimizing: Performance of the process is optimized to meet current and future business needs, and the process achieves repeatability in meeting its defined business goals	5. Optimizing: Continuous process improvement is enabled by quantitative feedback from the process and from piloting innovative ideas and technologies

- ISO/IEC 15504 [31], which has been revised in 2015 by ISO/IEC 33004 [32], sets out the requirements for process reference models, process assessment models, and maturity models for software engineering;
- ISO 13407 [26], which has been revised in 2019 by ISO 9241-210 [29], provides requirements and recommendations for human-centred design principles and activities throughout the lifecycle of computer-based interactive systems;
- ISO/TR 18529 [33], which has been revised in 2019 by ISO 9241-220 [30], describes the processes and specifies the outcomes by which human-centred design is carried out within organizations;

– ISO18152 [34] presents a human-systems (HS) model for use in ISO/IEC 15504-conformant assessment of the maturity of an organization in performing the processes that make a system usable, healthy and safe.

Table 2. Summary findings of systematic literature review of UCMMs/UXCMMs [42] (AUCDI stands for agile user-centered design integration, HF for human factors, HS for human-systems, U for usability, UX for user experience).

Year	Reference	Process assessment model	Process reference model	Domain
1998	[18]	6 tailored levels		U
2000	[19]	ISO 15504 [31]	ISO 13407 [26]	HF
2000	[33]	ISO 15504 [31]	ISO 13407 [26]	U
2001	[86]	CMM [67]		U
2003	[36]	ISO 15504 [31]	ISO 13407 [26]	U
2007	[78]	CMM [67]		UX
2009	[55]	CMM [67]		U/UX
2009	[84]	5 tailored levels		UX
2010	[34]	ISO 15504 [31]	ISO 13407 [26]	HS
2011	[24]	5 tailored levels		U
2012	[70]	5 tailored levels		U
2013	[60]	6 tailored levels		AUCDI
2014	[12]	5 tailored levels		UX
2014	[68]	CMM [67]		agile
2016	[41]	3 tailored levels		U

Table 2 summarizes the findings of a 2018 systematic literature review (SLR) of UCMMs/UXCMMs [42] that identified and analyzed 15 UCMMs/UXCMMs in total. The observed trends can be synthesized as follows:

– Regarding measurement scales, half of the process assessment models (8 out of 15) conform either with ISO 15504 [31] or with the software CMM [67], while the other half informs a tailored capacity/maturity scale (column 3);
– Only a quarter of the UCMMs/UXCMMs (4 out of 15) explicitly defines ISO 13407 [26] as process reference model, the remaining 75% not providing any such information (column 4);
– A large majority of UCMMs/UXCMMs (13 out of 15) focuses on usability, user experience and related disciplines, while only 15% are tailored for agile software development or agile user-centered design integration (column 5);
– There is a clear split between the 2000s when most UCMMs/UXCMMs were compliant with or based on existing models and the 2010s when user-centered design is tailored, in all likelihood, to fit more specific domains and contexts.

The 2018 SLR [42] also indicates the following:

– There is a lack of information on how most UCMMs/UXCMMs (9 out of 15) were evaluated, which leaves their validity questionable;
– Two-thirds of the UCMMs/UXCMMs (10 out of 15) provide no or limited guidance for the use of their process assessment model, which hinders their application or adoption in practice; the five remaining UCMMs/UXCMMs [18,33,34,36,60] provide a glossary of key terms and detailed information on how to carry out the process assessment;
– Two-thirds of the process assessment models (10 out of 15) focus managing the UX process (defining, scoping, controlling); one focuses only on executing the UX process (performing UX activities); the remaining four PRMs [34,36,68,86] focus on both process management and process execution.

3 Contribution

We argue that planning activities (e.g. scoping, defining, benchmarking) and execution activities (e.g. monitoring, performing, controlling) take place within two distinct processes, namely planning and execution, as they do not have the same purpose and do not involve the same stakeholders [27]. While the planning process intends to specify the activities to be performed to achieve the project goals, the execution process consists in actually performing these activities. While the planning process involves a wide range of stakeholders (steering committee, sponsor, special interest groups, customers, project team), the execution process involves the project team and the users.

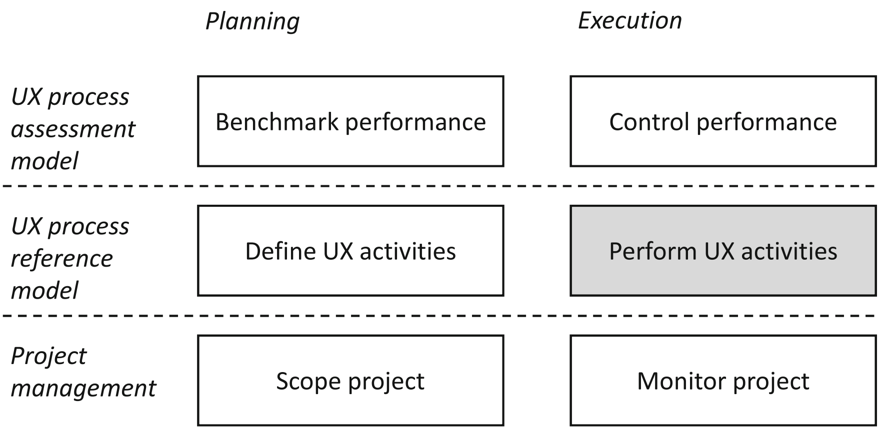

Fig. 1. Contribution of the paper (grey rectangle).

We propose a process reference model for UX (UXPRM), which focuses on the execution of UX activities (Fig. 1). The UXPRM includes a description of the primary UX lifecycle processes within a UX lifecycle and a set of supporting UX methods. The primary UX lifecycle processes are refined into objectives, outcomes and base practices. The supporting UX methods are refined into related techniques, specific objectives and references to the related documentation available in the literature.

The contribution of the proposed UXPRM is conceptual, practical and methodological. The conceptual contribution lies in the choice to leave the planning of UX processes aside, and to focus on the execution of UX processes. This conceptual choice is original compared to existing UCMMs/UXCMMs which either define ISO 13407 [26] as PRM and therefore include planning, or do not explicit define any such PRM. This conceptual choice also better matches what happens in practice, for example when the planning activities occur months ahead of the project launch, as it is the case during seeking funding. This conceptual choice has practical implications, as it makes the PRM customizable for different settings (e.g. agile vs. waterfall, in-house team vs. group of organizations). The methodological contribution of the proposed UXPRM lies in the detailed description of the supporting UX methods. This detailed description draws an accurate picture of the UX methods currently available and allows, we believe, the reader to make more informed decision while selecting UX methods and techniques.

4 Methodology

4.1 Comparison of the Related Work

To identify the primary UX lifecycle processes and organize them within a UX lifecycle, we compared the lifecycles in user-centered methodologies. The user-centered methodologies are usability engineering (UE), human-centered design (HCD), user-centered design (UCD) and agile user-centered design integration (AUCDI). We have selected these four methodologies as they involve user-centered methods articulated across a lifecycle.

UE is a set of activities that take place throughout a lifecycle and focus on evaluating and improving the usability of interactive systems [57,62]. UE base practices include conducting analysis activities early in the product development lifecycle, before design activities in order to specify the needs and the requirements of users. In line with this recommendation, additional references demonstrate the significance of such early stages activities [6,24].

HCD [29] and UCD [36] both aim to develop systems with high usability by incorporating the user's perspective into the software development process. In this regard, the user requirements specification (URS) is critical to the success of interactive systems and user requirements (UR) are refined iteratively throughout the lifecycle [51,52].

AUCDI is concerned with the integration of UCD into agile software development methods. The scientific consensus on AUCDI is that agile and UCD should be iterative and incremental, organized in parallel tracks, and continuously involve users [8,74]. The barriers to AUCDI are the lack of time for upfront analysis and the difficulty optimizing the work dynamics between developers and designers [15, 22]. Several models have been proposed for supporting the management of the AUCDI process [20, 49].

Figure 2 compares the user-centered lifecycles found in the related work. We conformed to ISO 24744 [31] in order to ensure a consistent, rigorous and up-to-date approach while expressing the processes involved in the user-centered lifecyles. ISO 24744 concerns method engineering and is aimed at expressing software processes involved in a workflow for any particular goal in software engineering. Figure 3 depicts the legend extracted from ISO 24744.

As can be seen from Fig. 2, user-centered lifecycles are very similar: they are iterative; they use a similar terminology (i.e., requirements, analysis, design, testing or evaluation); except for the AUCDI lifecycle, they follow a similar sequence of processes: analysis, design and evaluation. The main difference between these lifecycles lies in the perspective on the requirements. Requirements correspond to a primary process in UE (see requirement analysis), HCD (see requirements specification) and in UCD (see user requirements). By contrast, in AUCDI, requirements correspond to a process outcome fed throughout the development lifecycle by the primary processes.

4.2 Targeted Literature Review

To identify the supporting UX methods, we ran a targeted literature review (TLR) which is a non-systematic, in-depth and informative literature review. A TLR is expected to guarantee keeping only the references maximizing rigorousness while minimizing selection bias. Contrastingly, systematic literature reviews usually aim at addressing a predefined research question by extensively and completely collecting all the references related to this question and by considering absolute inclusion and exclusion criteria. Inclusion criteria retain references that fall in scope of the research question, while exclusion criteria reject irrelevant or non-rigorous references.

We chose to run a TLR for the following four reasons:

1. Translating our research question into a representative syntactical query to be applied on digital libraries is not straightforward and may lead to many irrelevant references [54];
2. If applied, such a query may result into a very large set of references that actually use a UX method, but which do not define any UX method or contribution to such a UX method;
3. The set of relevant references obtained through TLR is quite limited and stems for a knowledgeable selection of high-quality, easy-to-identify references on UX methods, as opposed to an all-encompassing list of irrelevant references;
4. A TLR is better suited at describing and understanding UX methods one by one, at comparing them, and at understanding the trends of the state of the art.

The TLR allowed us to identified 59 relevant references documenting UX methods, UX techniques and UX artifacts (Table 3).

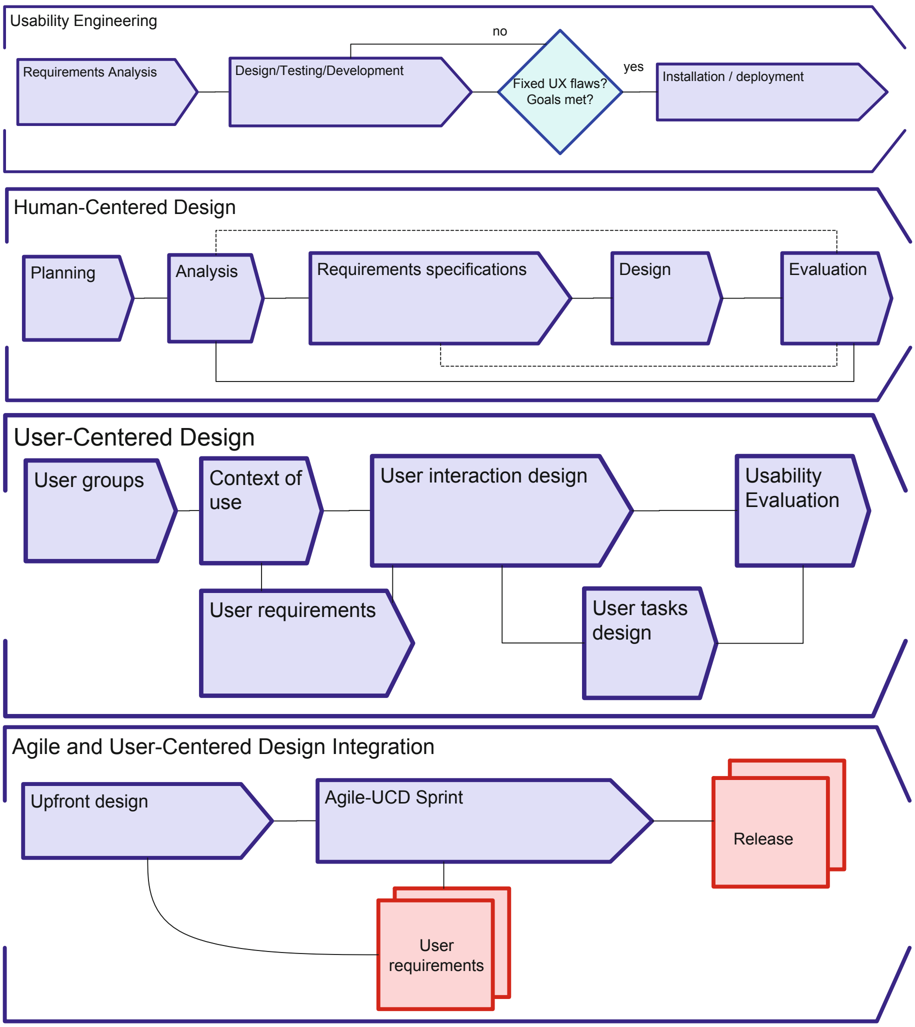

Fig. 2. Comparison of the lifecycles in user-centered methodologies specified according to ISO 24744 [28,77].

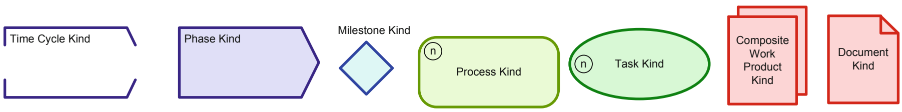

Fig. 3. Legend extracted from ISO 24744 [31,77].

Table 3. References identified by the targeted literature review.

Method	Techniques	References
Without users		
GOMS models	CMN-GOMS, CPM-GOMS, NGOMSL, Keystroke-Level Model	[10,35]
hierarchical task analysis	hierarchical task analysis	[14,59]
inspection	abstract tasks; cognitive walkthrough; guideline/expert review; heuristic evaluation	[45,46,53,57,64]
Attitudinal		
cards	cards; emocards; emotion cards	[22,88]
experience sampling	automated interaction logs; daily diary; repeated-entry diary	[11,37,39,71,80,87]
group interview	brainstorming; focus group; group discussion; questionnaire	[13,14,21,25,43,51,57]
interview	structured (questionnaire, role-play, twenty questions) or unstructured	[13,14,21,25,43,51,57]
retrospective interview	cognitive interview; elicitation interview	[13,14,21,25,57]
survey	interview; questionnaire	[13,14,21,43,44,47,51]
verbal protocol	co-discovery; talk-aloud; think-aloud; retrospective think-aloud	[13,14,16]
Behavioral		
constructive	collage; drawings; photographs; probes	[4,16]
experiment	A/B testing; controlled experiment; remote experiment; user test	[15,23,38,57,81,82]
observation	field or systemic observation; shadowing; applied ethnography	[14,16,25,51,57,59,82]
simulation	paper-and-pencil evaluation; Wizard of Oz experiment	[3,48,57,58,82,89]
Attitudinal and behavioral		
contextual inquiry	contextual observations and interviews	[16,25,57]
Design		
goals setting	user, usability, UX goals	[25,52,57,79]
mapping	concept map; customer journey map; service blueprint	[7,14,22,65,83]
sorting	affinity diagram; card sort	[14,25,65]
scenario	storyboard; use case; user scenario; user story	[8,22,25,52,57,66,90]
modeling	persona; work model; task model; UI model	[9,22,23,25,56,61]
lo-fi prototyping	paper prototype; PowerPoint prototype; sketch	[3,22,48,57,58]
me-fi prototyping	video prototype; wireframe; Wizard of Oz prototype	[3,22,48,50,57,58]
hi-fi prototyping	coded prototype	[3,22,58]
visual design	visual techniques	[85]
guidelines and standards	design principles; standards; style guide	[57,69]

4.3 Classification of UX Methods

To classify the UX methods, we adopted a bottom-up approach. First, we distinguished between methods and techniques by adopting the following hierarchical arrangement between approach, method and technique: *The organizational key is that techniques carry out a method which is consistent with an approach* [2]. For example, heuristic evaluation is a technique to carry out inspection (method), brainstorming is a technique to carry out a group interview (method).

Second, we grouped the UX techniques allowing to carry out the same UX method (Table 3). For example, heuristic evaluation and expert review are techniques to carry out inspection, brainstorming and focus group are techniques to carry out a group interview.

Third, we defined four levels of representation of the users and plotted the number of reference documenting a technique along two axes: the continuum from level 1 to level 4 and the methods (Fig. 4). The resulting levels of representation of the users correspond to four classes of UX methods:

1. Methods without users;
2. Attitudinal methods which focus on how users feel;
3. Behavioral methods which focus on what users do;
4. Attitudinal and behavioral methods which combine classes 2 and 3.

4.4 Classification of UX Artifacts

To classify the UX artifacts, we proceeded in a similar way by grouping UX artifacts which result from the same UX method. for example, affinity diagrams and card sorts result from sorting, and personas and work models result from modeling. We defined ten levels of representation of the system and grouped the artifacts by levels (Table 3). The levels of representation of the system are:

1. Goal setting: linguistic description of the design and UX goals;
2. Mapping: arrangement of concepts and ideas on a diagram;
3. Sorting: arrangement of data by their common features;
4. Scenario: written outline of the UX giving details on individual user actions;
5. Modeling: structured representation of users, tasks, work and environments;
6. Low-fidelity (lo-fi) prototyping;
7. Medium-fidelity (me-fi) prototyping;
8. High-fidelity (hi-fi) prototyping;
9. Visual design: visual techniques (e.g. color, shape, orientation, etc.);
10. Guidelines and standards: combination of previous levels.

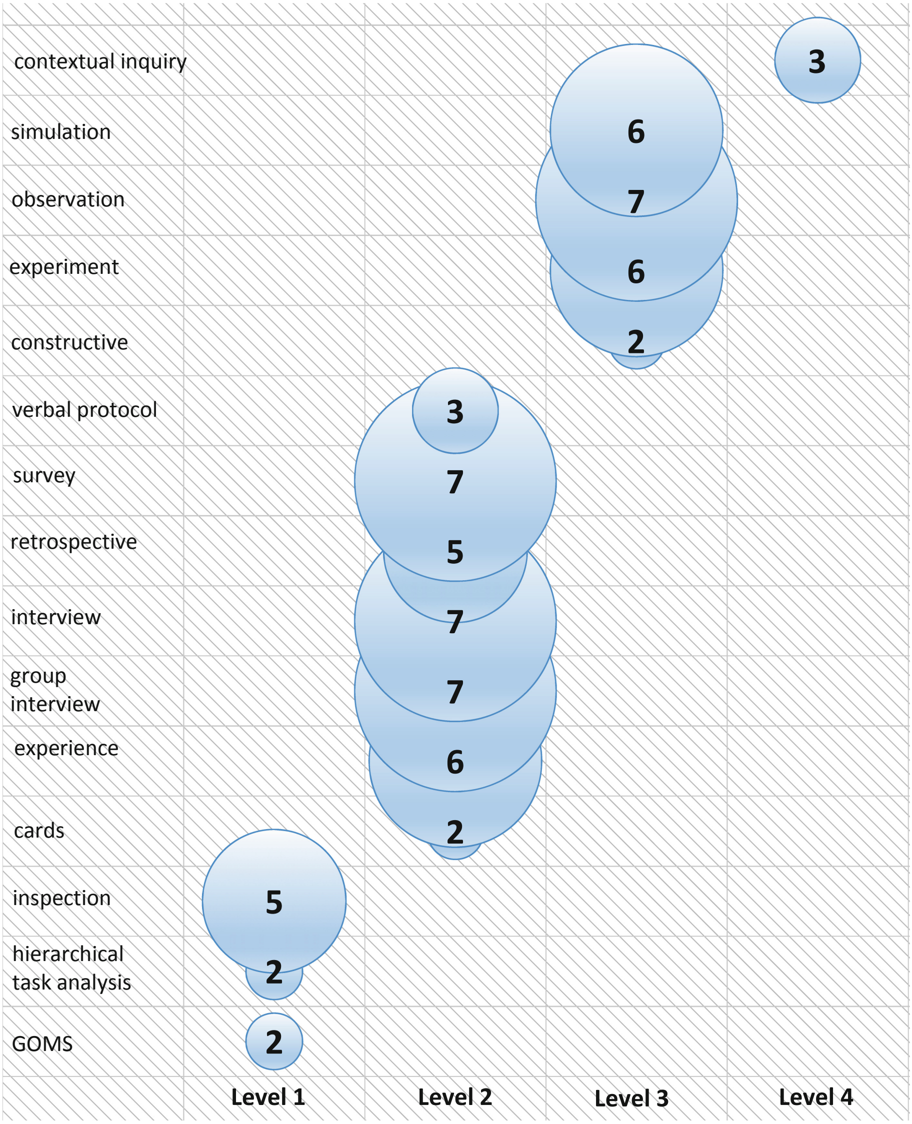

Fig. 4. Bubble chart expressing to what extent references examined in this paper cover each UX method (the size of each circle is directly proportional to the amount of references found per UX method: the larger the circle, the more references).

5 Results

5.1 Primary UX Lifecycle Processes Within a UX Lifecycle

Figure 5 depicts the primary UX lifecycle processes within a UX lifecycle specified with ISO24744 [28]. The proposed UX lifecycle involves four primary pro-

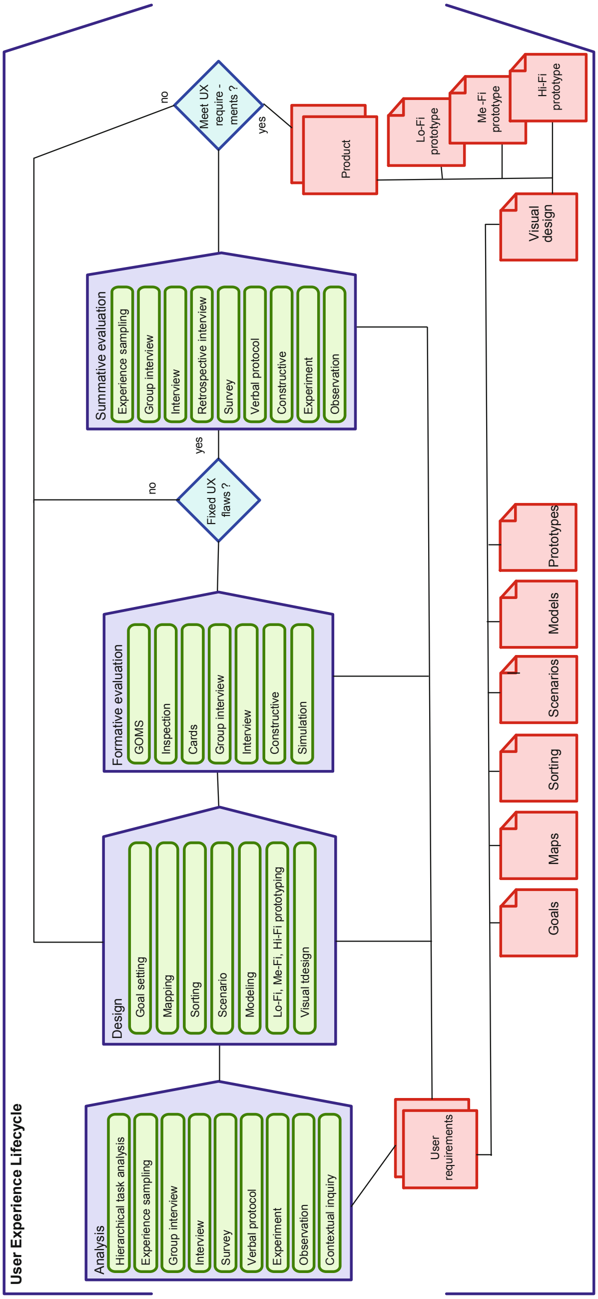

Fig. 5. Primary UX lifecycle processes specified according to ISO 24744 [28,77].

cesses or phases (analysis, design, formative evaluation and summative evaluation) and produces two outcomes (the user requirements and the product). We chose the name of primary processes and outcomes according to their frequency in the related work. We aligned the four primary processes with the sequence (analysis, design and evaluation) identified in the related work. The proposed UX lifecycle is iterative: While there are UX flaws, go back to design (see milestone "Fixed UX flaws?"); While UX requirements are not met, go back to design (see milestone "Meet UX requirements?").

The URS is a composite work product which results from the iterative and incremental consolidation of processes' outcomes. Specifically, the analysis of the context of use documents a first version of the UR which is later revised or completed by other work products (e.g. personas, prototypes or guidelines) as the design and evaluation processes take place. Typically, the URS includes the following sections: the specification of the context of use, the specification of UX goals and UX design (e.g. interaction styles, screen design standards or strategies for the prevention of user errors [57]), the measurable benchmarks against which the emerging design can be tested, and the evidence of acceptance of the requirements by the stakeholders [51,52]. Figure 6 depicts graphically the activities typically related to the specification of user requirements.

Similarly, the product is a composite work product which results from the iterative and incremental development of prototypes, from lo-fi to hi-fi prototypes.

5.2 UX Base Practices

Analysis. The analysis process primarily aims to render a first account of the UR. The objectives of this process are to specify the context of use, to gather and analyze information about the user needs, and to define UX goals. The analysis of user needs consists of defining which key features users need to achieve their goals. User goals refer here to both pragmatic goals (e.g. success or productivity) and hedonic goals (e.g. fun or arousal) [5]. The success of this process relies on the early involvement of users, as it improves the completeness and accuracy of the user requirements [52]. The outcomes of analysis directly feed into the UR and, at the same time, become inputs of the design.

Design. The design process primarily aims to turn ideas into testable prototypes. The objective of this process is to provide the software development team with a model to follow during coding. Typically, a style guide documents this model which includes information architecture design, interaction design (IxD), user interface (UI) design and visual design. The Cameleon Reference Framework [9] recommends modeling the user interface incrementally according to three levels of abstraction (abstract, concrete and final) which correspond to similar levels recommended in the *Usability Engineering Lifecycle* (conceptual model design, screen design standards and detailed UI) [57]. Another approach consists in reasoning according to the level of fidelity (low, medium and high)

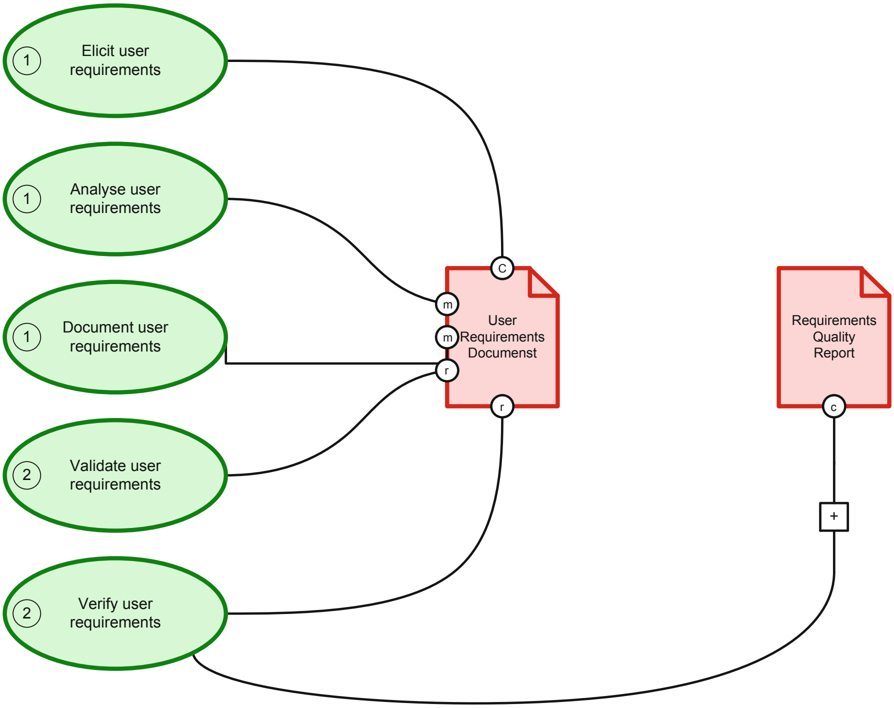

Fig. 6. Activities related to user requirements.

of prototypes [48,58,89]. The outcomes of the design process such as conceptual models or screen design standards directly feed into the URS, while the product representation (e.g. paper prototype) becomes an input of the formative evaluation process.

Formative Evaluation. The formative evaluation process primarily aims to detect UX design flaws in the product representation. As long as there are such flaws, the design process supports the production of redesign solutions to fix them. Design and formative evaluation are therefore intertwined within an iterative and incremental test-and-refine process that aims to improve the product representation. The product development team repeats this cycle until UX flaws are fixed. Once they are fixed, the redesigned solution becomes an input of the summative evaluation process. The relevant literature [9,20,25,57,68] is consistent regarding this iterative and incremental aspect of the design process. In addition, formative evaluation requires low investment in resources and effort, which efficiently supports decision-making and significantly helps reducing late design changes [3,6,57,62,82].

Summative Evaluation. The summative evaluation process primarily aims to check whether the design solution meets the UX goals documented in the URS. The objective of this process is to measure the UX with the testable prototype and to compare results against UX goals. The evaluation of earlier design solutions relies on formative evaluation, which refers to the iterative improvement of the design solutions. On the other hand, the evaluation of later design solutions typically involves summative evaluation, which refers to finding out whether users can use the product successfully. When UX goals are met, design solutions documented in the URS are updated, while prototypes become inputs of coding.

5.3 Supporting UX Methods

There are five classes of UX methods. The knowledge elicitation methods without users (class 1) aim to predict the use of a system. These methods do not involve user data collection; instead, they rely on the opinion or expertise of an expert. The knowledge elicitation methods involving users consist in collecting user data in order to incorporate the user's perspective into software development. The data collection focuses on users' attitude (class 2), on users' behavior (class 3) or on both users' attitude and behavior (class 4). The design methods (class 5) aim to represent the user and the system by means of artifacts. The design methods are also referred to as artifact-mediated communication methods [8]. Table 4 depicts the specific objectives of each UX method identified in this paper.

6 Application: Past, Present and Future Work

We use the UX process reference model in an industrial project entitled Voice Interface for Autonomous Driving based on User experienCe (VIADUCT). Launched in November 2018, the project aims to design new user experiences with the driving monitoring system (DMS) and is funded for 36 months under the reference 7982 by Service public de Wallonie (SPW), Belgium. The consortium of partners involves six institutions (two private companies, two universities and two accredited research centers) and uses an agile approach for software development. In this project, the mission of the two first authors is to support the integration and establishment of UX practice in the project organization. We use the UXPRM in the following ways.

First, we used an earlier version of the UXPRM during the project definition and planning phase (i.e. before we submitted the proposal to the project sponsor) in order to scope and define the UX methods that would be used during project development. This set of UX methods includes all the design methods referenced in this paper plus a selection of evaluation methods namely interview, survey, verbal protocol, experiment, observation and simulation (Table 4).

Second, we used the UXPRM during the project launch phase (i.e. for a period of three months starting from the kick-off) in order to communicate

Table 4. Objectives of UX methods.

Method	Objectives
Without users	
GOMS models	to predict how users will use a system
hierarchical task analysis	to capture the mental demands needed to perform a task proficiently with a system
inspection	to predict the learnability of a system or potential usability and UX problems
Attitudinal	
cards	to identify user mood and reactions about their experience with a system
experience sampling	to capture user thoughts, feelings on multiple occasions over time
group interview	to collect data from a purposely selected group of individuals about a specific topic
interview	to collect data from individuals about their attitudes, beliefs, habits, norms and values
retrospective interview	to capture the aspects of cognitive performance during user past experience with a system
survey	to collect data from a sample population about a system
verbal protocol	to make thought, cognitive processes as explicit as possible during task performance
Behavioral	
constructive	to identify unexpected uses of a system or concept
experiment	to test a hypothesis or establish a cause-and-effect relationship about a system or a sample population
observation	to capture how users perform tasks or solve problems in their natural setting
simulation	to detect UX problems with a system which has not been implemented yet
Attitudinal and behavioral	
contextual inquiry	to capture how users perform their tasks, achieve their intended goals and think about their work
Design	
goals setting	to document specific qualitative and quantitative goals that will drive UX design
mapping	to represent relationships between concepts and ideas
sorting	to cluster and label data based on relationships that make sense to users
scenarizing	to depict how users achieve their goals with a system, to describe a software feature from the user's perspective
modeling	to depict users, work organization, tasks and UIs
lo-fi prototyping	to turn design ideas into testable mock-ups
me-fi prototyping	to capture and illustrate how users will interact with a new system
hi-fi prototyping	to turn mock-ups into highly-functional and interactive prototypes
visual design	to arrange screens in such a way that they communicate ideas clearly, consistently and aesthetically
guidelines and standards	to provide developers with a model to follow during coding

about primary UX lifecycle processes, especially to advocate for the integration of analysis activities in the product development lifecycle. This allowed us to carry out little upfront analysis (i.e. refine use cases into user scenarios) by means of workshop and brainstorming, which both fall under the group discussion category.

Third, we currently use the UXPRM in order to provide the consortium with a plan of the UX activities that will take place in the next six months. In such a hybrid project environment (academic and industrial), the releases are less frequent as the agile iterations stretch from two weeks to 6–8 weeks [1]. Therefore, we will synchronize these activities with the agile retrospective, that being at the end of each iteration. The UX activities will take place in the form of workshops with the goal of delivering collectively a UX work product. The first rounds focused on modeling (e.g. personas, work models and task models) with the purpose of encouraging the reuse of such UX work products, and by doing so, increasing the return on investment of UX [6].

In the future, we will use the UXPRM to specify a companion UX process assessment model (UXPAM). Specifically, we will use the processes' attributes presented in this paper (i.e. methods, techniques, base practices, data collection and analysis, goal setting and work products) as indicators of the capability/maturity of processes. We have proposed a first version this UXPAM [73] which defines the process attributes, the measurement scales and the tools for the assessment (questionnaire and interview guide). This work-in-progress has allowed us to gain insights into the current use of UX methods in the project organization (essentially hi-fi prototyping and scenarizing), to identify the barriers in the way of UX integration (hostility towards upfront analysis and lack of understanding of the return on investment of UX) and opportunities for the integration of UX in the formal software development model (identification of "UX champion" in the consortium). Practically, we will use the UX workshops aforementioned as forums to perform the data collection for small-scale process assessment. These small-scale process assessments will allow us to populate and test the proposed UXPAM, which is essential for the development of maturity models [17] and to monitor the evolution of the UX capability/maturity.

Finally, we argue that the definition of UX activities, which is a planning process, must depend on the project scope (detailed set of deliverables or features of a project) and current capabilities of an organization to achieve UX goals. Furthermore, we argue that UX activity plans must result from the alignment between the business goals of the organization (project management), the level of UX capability/maturity of the organization (UXPAM) and the level of effort that is required to successfully implement UX methods (UXPRM). Table 5 provides an early draft of the level of effort required by the UX methods referenced in this paper as it is documented in the related work [6, 51]. Building on this basis, our future work will consist of studying this alignment (Fig. 7).

Table 5. Level of effort per UX method in man-days as documented in [6,51] (CM stands for conceptual model, SDS for screen design standards; question marks indicate uncertainty in the measurement of man-days for a particular technique, blanks that the method was not documented).

Method	Techniques and effort [6]		Techniques and effort [51]	
Without users				
GOMS models				
hierarchical task analysis				
inspection			design guidelines and standards	2–5
			evaluation walk-through	3–6
			heuristic evaluation	2–3
Attitudinal				
cards				
experience sampling			diary keeping	8–15
group interview	conduct needs finding	1	context-of-use analysis	1–2
			focus group	8–15
			brainstorming	2–3
interview	questionnaire	4–8	stakeholder analysis	1
			user requirements interview	5–8
			satisfaction questionnaire	2–4
			post-experience interview	3–4
retrospective interview				
survey			survey of existing users	6–15
verbal protocol				
Behavioral				
constructive				
experiment			controlled user testing	10–16
observation			field study/user observation	5–8
			participatory evaluation	4–8
			evaluation workshop	3–6
			assisted evaluation	5–9
simulation	iterative CM evaluation	14–16	paper, video evaluation	?
	iterative SDS evaluation	14–21	WOz experiment	?
	iterative detailed UI evaluation	14–21		
Attitudinal and behavioral				
contextual inquiry	contextual task analysis	10–16	task analysis	6–15
			assessing cognitive workload	4–8
			critical incidents	6–10
Design				
goals setting	usability goals	2–4	user requirements	2–4
mapping			task/function mapping	4–6
sorting	card sorting	4–6	card sorting	2–3
			affinity diagram	2–3
scenarizing			scenario of use	3–6
			storyboarding	4–6
modeling	user profile	4	personas	1–2
	work modeling	4		
	work reengineering	10–12		
	conceptual model design	10–12		
lo-fi prototyping	CM design	4–5	parallel design	3–6
			paper prototyping	?
me-fi prototyping	SDS design	4–14	video prototyping	?
			WOz prototyping	?
hi-fi prototyping	detailed UI design	10–12	software prototyping	?
visual design				
guidelines and standards				

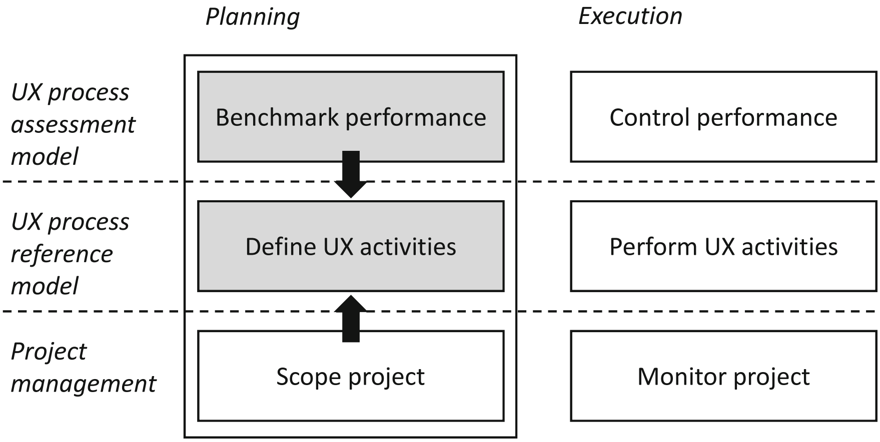

Fig. 7. Focus of our future work (grey rectangles).

7 Conclusion

We propose a process reference model for UX, which focuses on the execution of UX activities. The UXPRM includes a description of the primary UX lifecycle processes within a UX lifecycle and a set of supporting UX methods. The primary UX lifecycle processes are refined into objectives, outcomes and base practices. The supporting UX methods are refined into related techniques, specific objectives and references to the related documentation available in the literature. The contribution of the proposed UXPRM is three-fold: conceptual, as it draws an accurate picture of the UX base practices; practical, as it is intended for both researchers and practitioners and customizable for different organizational settings; methodological, as it supports researchers and practitioners to make informed decisions while selecting UX methods and techniques. This is a first step towards the strategic planning of UX activities.

Building on the promising usefulness of the proposed UXPRM for supporting UX practice, our future work consists of developing a UX processes assessment model (UXPAM), which is a measurement structure for the assessment of UX processes. We argue that UX activity planning depends on the alignment between business goals, level of UX capability/maturity and the level of effort required to successfully implement UX methods. In turn, this aims to reducing the gap between UX research and UX practice.

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