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UPCASE - A METHOD FOR SELF-ASSESSING THE CAPABILITY OF THE USABILITY PROCESS IN SMALL ORGANIZATIONS

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Abstract

One of the best ways for an organization to start a software process improvement program is performing a process assessment. These assessments are typically performed by external assessors. Yet, an alternative for companies seeking for lighter assessments, especially small organizations, are self-assessments that can be carried out by an organization to assess the capability of its own process.

In this way, the need to develop UPCASE has arisen. As far as we know, UPCASE is the first method for self-assessing the capability of the usability process in small organizations. This technical report aims at presenting the development of the Process reference model (PRM) and Process assessment model (PAM) of the UPCASE method. To guide the development of UPCASE, a series of requirements have been established to ensure that the method meets the needs of small organizations and in fact measures the capability their usability processes. The structure of the PRM and the PAM is elaborated based on ISO/IEC 29110-3, a technical report on conducting process assessment in small organizations, and ISO 15504-4, a technical report that provides guidance on how to utilize a conformant process assessment within a process improvement program or for process capability determination. The content of the PRM was based on ISO/IEC 18529, a technical report which contains a process reference model for the Human-centred design process.

UPCASE's PRM has 4 process groups and a total of 16 processes, each process having a purpose and a set of outcomes. The PAM contains an indicator for each PRM process. For each indicator is provided a description, a list of possible work products and techniques to obtain them, as well as examples for each work product, in order to assist the assessor and facilitate the assessor.

1. Introduction

Self-assessment of software process

Software process improvement (SPI) is been a proven way to increase product quality, with fewer resources and less time, allowing software companies to stand out from the competitors [1], [2], [3]. In addition, improving software processes can reduce time to market, increase productivity, organizational flexibility, and customer satisfaction [4], [5], [6].

Process assessment is among the first activities performed when an organization starts a SPI program [7], [8]. Process assessment is an evaluation of an organization's processes against a reference model. The result of the assessment is an indicator of how well the organization's processes meet the requirements of the process reference model [9]. In addition to starting the process improvement program, assessment can be performed at other moments during the program, such as during monitoring and at the end, to compare with the outcome of the assessment made before the improvement or even to achieve a Certification. The process assessment can be carried out using different approaches, through a self-assessment (performed by the organization itself being assessed), or by an independent assessment (performed by assessor extern to the organization being assessed).

In order to perform a process assessment, Process Assessment Models (PAM), also called Software Process Capability/Maturity Models (SPCMMs), are typically used. They describe the life cycle processes and the process management principles [10]. There exists several SPCMMs, the most widely used of them currently are the ones from CMMI, as for example, CMMI-DEV [11] and CMMI-SRV [12] and the ones that conform ISO/IEC 15504, as for example, ISO/IEC 15504-5 [13] and Automotive SPICE [14]. Besides the popularity of CMMI and ISO/IEC 15504, they are mostly applied in large companies, not being popular among small and agile enterprises [25]. This is due to their detailed assessment procedure that requires considerable effort and consequently increase costs, making them often impossible for small enterprises[24], [8], [15],[16], [18], [27]. In addition, companies believe that SPA requires certain degree of detail that increases corporate bureaucracy [20]. Another reason that makes SPAs less attractive to small companies is the difficulty of understanding and implementing them in practice [17], [19]. This fact leads many companies to seek even more for simplicity of processes and as result they are increasingly attracted to agile methods. Despite the challenges most organizations have to assess their processes, it is very important that this be done, since it allows identifying organization's strengths and weaknesses and, thus, being a first step towards improving the software process [21], [16].

Motivated by the need for less complex and more agile approaches, orientations to guide lighter assessments in small companies are developed, ISO/IEC TR 29110-3-1 [23]. In this context [22], an alternative are self-assessments, the most common way to conduct a SPA for organizations that do not aim for certification [28]. The popularity of self-assessments lies in

their low cost, good accessibility and ownership of results [28], [27]. Self-assessments are assessments carried out by an organization to assess the capability of its own process, not requiring the involvement of SPI experts. The sponsor of a self-assessment is normally internal to the organization as are the member(s) of the assessment team [10]. The assessment team is responsible for collecting and analyzing data and reports the assessment results. Data may be collected using a single method, such as via survey, interviews or through a workshop.

As self-assessments are conducted by the organization's own human resources and use less bureaucratic methods, it results in more simplified way to perform an assessment, in a shorter period of time and using fewer resources [26], [27].

Usability process assessment models

Software applications nowadays are present in a diverse range of devices, such as computers, tablets, mobile phones, digital TVs, refrigerators, etc. for numerous kinds of activities, from researching a health condition, entertainment to accessing educational resources [1]. Such changes have a significant impact on the nature of user interaction, as they offer new ways of interaction anywhere, anytime by anyone [29], [30]. This, on the other hand, makes usability an even more important quality attribute of software today [31], [32].

Usability is the extent to which a product can be used by specific users to achieve specific goals with effectiveness, efficiency and satisfaction in a specific context of use [33]. Usability flaws may impede the users to complete their tasks or annoy them when interaction is designed unnecessarily complex or time-consuming [34]. Furthermore, in critical contexts, such as health applications, which may impact on the health of humans, usage errors may compromise patient safety leading to injury or even death [35]. On the other hand, investing in usability by designing software through a user-centered design process can not only improve usability but also reduce overall development cost by avoiding rework at late stages in the lifecycle [36] and speed up development [37], [38]. Moreover, usability can provide a competitive edge increasing sales and retaining customers, increasing user satisfaction and software acceptance [38],[39]. Thus, the question is of how to develop software products with usability?

As any other product quality, usability is also directly influenced by the software process quality [40], and, thus it is important to establish appropriate processes for usability engineering. Usability engineering (UE) is the application of systematic, disciplined, quantifiable methods to the development of interactive software systems to achieve a high quality in use [41]. Hence, in order to develop products on a certain level of usability, UE processes need to be defined and implemented.

To guide the definition and implementation of software processes, typically SPCMMs are used. Besides these generic SPCMMs intended to be applicable in any context, it is

observed a trend to the customization of such models to target more specifically certain contexts. So far diverse kinds of customizations of SPCMMs have been developed [42], such as for certain types of systems, including medical devices [43], or automotive sector [44] or focusing on specific quality aspects, such as systems security [46], user centered design [47] or specific types of software development approaches, such as hybrid traditional-agile approaches [48]. Such customized models may provide more specialized support facilitating process improvement and assessment by adapting process requirements and/or providing further support for their application, for example, through low cost assessment methods or reducing the need for documentation [45], [49], [11]. However, taking into account that usability is an important software product quality characteristic, it seems that there are no generic SPCMMs that include processes specifically aiming at usability [50]. This means, that, even software organizations at the highest level of maturity seem not to be required to have established any usability engineering processes [51].

On the other hand, there exist few SPCMMs focusing exclusively on usability engineering processes (such as UCDM [52], ULMM [53], UMM-P [54]) [55]. Although these models specify high-level requirements to the usability process, they seem not to provide enough information on how to assess and/or implement them in practice, which may hinder a large-scale adoption. And, although such generic capability/maturity models are supposed to be applicable in any kind of context, it remains questionable, if they are also valid, reliable and cost efficient in current software development contexts due to a lack of validation of these models [55].

For small companies, however, these models are not attractive and, thus, not largely used [25]. Yet, there exists a trend towards developing lighter approaches allowing the performance of self-assessments. In this context, self-assessment is a more attractive assessment method for companies that do not aim for certification, and so can carry out assessments more quickly and with lower cost. Although there are SPCMMs to assess usability engineering processes, important nowadays for successful software development, however, none of them provides a self-assessment method.

Considering this lack of self-assessment methods specifically for assessing the capability of usability process this work aims at developing UPCASE, a usability capability self-assessment method.

2. Requirements to a Self-Assessment Method for Assessing the Usability Process in Small Enterprises

In order to develop an effective and efficient method for self-assessing usability processes on small companies, a set of requirements is elicited (Table 1). The proposed requirements are based on the requirements for software and usability process assessment methods, process self-assessment and based on needs and characteristics of small enterprises found in a literature.

In addition, it is desirable for UPCASE to have a conformity assessment process with ISO/IEC 29110-3, as it is an internationally recognized series of technical reports on conducting process assessment in small organizations. ISO/IEC 29110-3 assessment process is based on ISO/IEC 15504, a series that provides a framework to perform assessment of processes. So, UPCASE includes requirements for the assessment method in general, and requirements specifically for each of the method elements, as defined by ISO/IEC 15504 [10] with respect to the process assessment, the measurement framework and the process reference model.

Table 1 - Requirements to a self-assessment method for assessing the usability process in small enterprises

No.	Requirement	Element	Reference(s)
1	The method should allow a fast-internal assessment.	Method	(M. Mirna et al., 2012) (Pino et al., 2010) (D. Hering et al., 2015) (Sánchez-Gordón et al., 2016)
2	The method should allow getting a snapshot of actual processes.	Method	(M. Mirna et al., 2012)
3	The method should be of low cost.	Method	(M. Mirna et al., 2012) (Sánchez-Gordón et al., 2016) (Anacleto et al., 2004)(Caffery, 2007) (Pino et al., 2010) (Sulayman et al., 2012)
4	The method should provide the necessary tools (there should be more automated tools, eliminating laborious manual work and extensive documentation).	Method	(M. Mirna et al., 2012) (Anacleto et al., 2004)(Caffery, 2007) Pino et al., 2010) (Sulayman et al., 2012)
5	The method should be based on already established SPI standards that are widely recognized.	Method	(Mishra et al., 2009) (Pino et al., 2008) (Anacleto et al., 2004)(Caffery, 2007) (Pino et al., 2010)
6	The method should not require staff to have prior SPI experience, specific software engineering knowledge nor external experts.	Method	(Mishra et al., 2009) (Anacleto et al., 2004)(Caffery, 2007) (Pino et al., 2010) (ISO/IEC 29110-4)
7	The method should provide accesses to a detailed definition of the process reference model and the assessment model, with descriptions of process purpose, process outcomes provided by the PRM and capability levels and process attributes. The rating scale need to be supported with a comprehensive set of indicators of process performance.	Method	(Anacleto et al., 2004)(Caffery, 2007) (Pino et al., 2010) ISO/IEC 29110-3-1

8	The method should be public available.	Method	(Anacleto et al., 2004)(Caffery, 2007) (Pino et al., 2010)
9	The method should support the identification of improvement suggestions.	Method	(Anacleto et al., 2004)(Caffery, 2007) (Pino et al., 2010)
10	The process assessment should guide the activities that need to be performed in an assessment. It should provide a clear definition of roles and their responsibilities and a detailed description of the assessment process, with simple recommendations.	Assessment Process	(M. Mirna et al., 2012) (Anacleto et al., 2004)(Caffery, 2007) Pino et al., 2010) (Sulayman et al., 2012) (Fuchs et al.,2012) (ISO/IEC 29110-4)
11	The process assessment should require few resources.	Assessment Process	(Sulayman et al., 2012) (Sánchez-Gordón et al., 2016)
12	The process assessment should consider the views of the team while deciding what needs to be improved.	Assessment Process	(Mishra et al., 2009)
13	The process assessment and measurement framework should facilitate self-assessment.	Assessment Process / Measurement framework	ISO/IEC29110-3-1 (Mishra et al., 2009)
14	The measurement framework should provide a basis for use in process improvement and capability determination.	Measurement framework	ISO/IEC29110-3-1
15	The measurement framework should take into account the context in which the assessed process is implemented.	Measurement framework	ISO/IEC29110-3-1
16	The measurement framework should produce a process capability scale.	Measurement framework	ISO/IEC29110-3-1
17	The measurement framework should be applicable across all application domains mainly for very small entities.	Measurement framework	ISO/IEC29110-3-1
18	The measurement framework should provide an objective benchmark between organizations.	Measurement framework	ISO/IEC29110-3-1
19	PRM processes should be light, easily implementable, representing well-focused life cycle profiles, not requiring processes that don't make sense.	Process Reference Model	(Sulayman et al., 2012) (Laporte et al., 2008) (M. Mirna et al., 2012)
20	PRM processes should avoid complex nomenclature, concepts and practices (SMEs have little awareness of usability concepts and usability standards. Their definition of usability is limited and inconsistent).	Process Reference Model	(O'Connor, 2009) (Renzi et al., 2015) (D. Hering et al., 2015) (Fuchs et al.,2012) (ISO/IEC 29110-4)
21	PRM processes should be strongly human oriented and communication between them is important (most of communication is performed face to face).	Process Reference Model	(O'Connor et al., 2014) (ISO/IEC 29110-4)
22	PRM processes should focus on the Engineering Process group (SME are less interested in the Management Process Group and the Support Process Group).	Process Reference Model	(Pino et al., 2009) (ISO/IEC 29110-4)
23	PRM processes should aim at involving user in the usability lifecycle. (Understanding users is considered important for startups and greater integration with user interferes positively in usability capability).	Process Reference Model	(Hokkanen et al., 2016) (Scheiber et al., 2012)
24	PRM processes should not impose rigorous and inflexible methods and practices.	Process Reference Model	(Hokkanen et al., 2016)
25	Practices should be simple (nowadays SMEs are generally immature in relation to the use of usability processes.)	Process Reference Model	(Scheiber et al., 2012)
26	PRM processes should be flexible and allow iteration.	Process Reference Model	(D. Hering et al., 2015)

3. UPCASE - A Method for Self-assessing the Capability of Usability Process of Small Enterprises

In the context of this Technical Report, it is understood that a method is a systematic approach to achieve a specific objective or result and that describes the characteristics of an ordered process or procedure used in the engineering of a product or in the performance of a service [57], [58]. Based on this definition, is proposed a method that aims at providing a systematic support for the self-assessment of usability processes in small software companies in satisfying the identified requirements in Section 2.

The method is based on the technical report ISO/IEC TR 29110-3-1 Assessment Guide, which is part of the series ISO/IEC 29110 Systems and software engineering - Lifecycle profiles for Very Small Entities (VSEs) [24]. This series aims to guide small software organizations in the development and/or maintenance of their products, as well as in the management of their projects. The assessment guide for ISO/IEC 29110-3 intents to evaluate the process capability based on a two-dimensional evaluation model, containing a process dimension and a quality dimension of the process[1].

This resulted in a simplification of the elements necessary to perform an assessment defined by ISO/IEC 20119-3-1, since only the elements related objective 1) were kept. Figure 1 shows the basic elements of UPCASE, adapted from ISO/IEC TR 29110-3-1.

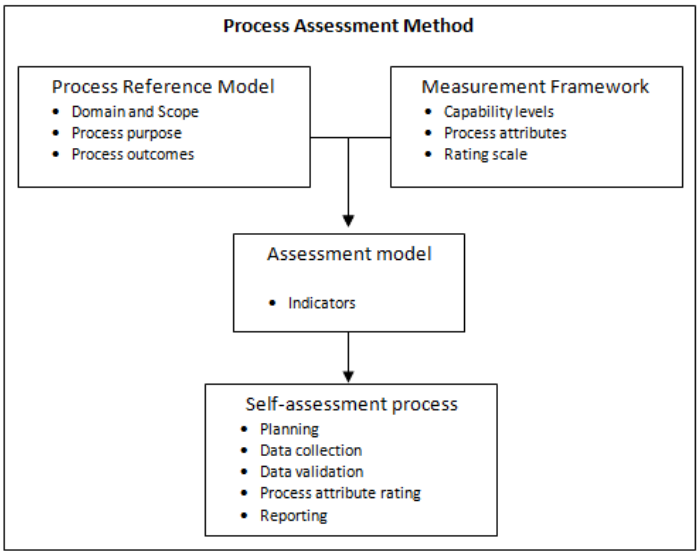

Figure 1Elements of the UPCASE assessment method (adapted from [23])

[1] The scope of the proposed method covers only this first objective of ISO/IEC TR 29110-3-1 not approaching the evaluation on whether an organization meets the desired profile based on the assessed capabilities for the processes, as UPCASE intends to assess usability processes of small companies of all profiles of the generic profile group.

The Process reference model comprises the definitions of processes in a life cycle described in terms of process purpose and outcomes. The Measurement framework provides a basis for rating the capability of processes, based on their achievement of defined process attributes. The Assessment Model is an operational model, used for performing assessments, which meets the defined requirements (with respect to model purpose, scope, elements and indicators, mapping to the reference model, and translation of results) in conformance with a reference process. The Self-assessment process is a guide for assessors to carrying out an assessment. It defines which activities should be performed as part of the assessment, as well as the roles, inputs and outputs of the assessment. The UPCASE self-assessment process uses a focus group method in order to collect and validate data from the assessment. To guide the focus groups and help to verify if the practices are performed or not, UPCASE provides a script in form of a questionnaire. The questionnaire is used by the assessor, which is responsible to moderate the focus groups.

3.1 Process reference model

The purpose of the Process Reference Model (PRM) is to define the usability processes, describing them in terms of process purpose and outcomes. Like the other elements of the proposed assessment method, UPCASE PRM is compliant with ISO/IEC 29110-3 and describes the following components [24]:

Process purpose: The process purpose consists of a single paragraph stating the purpose of the process describing the overall objectives of performing the process. It is supplemented by an enumeration of the principal process outcomes associated with that process.

Process outcomes: A process outcome is an observable result of the successful implementation of a process. Process outcomes are normally worded as descriptive statements.

There exists several usability PRMs [56]. Among them, the most comprehensive ones, which cover a wide range of human activities related to software development, are described by ISO/IEC 18152 and ISO/IEC 18529 [56]. The PRM described by ISO/IEC 18152 presents a wider scope and may be used in larger or more complex projects, covering the whole range of Human Centered Design activities (HCD) involved in systems engineering. In addition to the HCD technical processes, it also defines 13 processes related to planning and management. This standard is compliant with ISO/IEC 15504 and provides detailed guidance on how to perform process assessment. However, no research results on its use in practice are reported. On the other hand, the PRM described by ISO/IEC 18529 is more focused on technical processes, including only one additional one dedicated to the planning and management of HCD. This standard is also compliant with ISO/IEC 15504 and provides detailed guidance to perform process assessments. Considering that small organizations generally need simpler

processes (REQ 19) and, typically, do not develop large and complex projects [59], it was chosen to base UPCASE's PRM on ISO/IEC 18529, since it focuses on technical process (in agreement with REQ 22). As result, the UPCASEs PRM includes four categories as defined in ISO/IEC 18529, as shown in Table 1.

Taking into consideration the requirements identified in Section 2 further adaptation have been done to customize the PRM to the specific needs and characteristics. Considering REQ 22, 3 processes from ISO/IEC 18529 were not included in UPCASE's PRM: HCD 1, HCD2 and HCD 7. HCD 1 and HCD 2 processes were excluded, because they deal mainly with management and business strategy practices, not focusing on technical practices. On the other hand, the HCD 7 process was excluded, as it deals with the implementation and support of the system practices that are generally not responsibility of small organizations. Table 2 details the selection of processes in accordance with the identified requirements in Section 2, presenting a justification for each excluded process (marked in red).

Table 2 – UPCASE Usability process

Process (based on ISO/IEC 18529)		Justification for exclusion
HCD 1	Ensure HCD content in systems strategy	REQ 22(Process should focus on engineering process)
HCD 2	Plan and manage the HCD process	REQ 22 (Process should focus on engineering process)
HCD 3 (UP 1)	Specify stakeholder and organisational requirements	
HCD 4 (UP 2)	Understand and specify the context of use	
HCD 5 (UP 3)	Produce design solutions	
HCD 6 (UP 4)	Evaluate designs against requirements	
HCD 7	Introduce and operate the system	REQ 22 (Process should focus on engineering process)

For each of the 4 processes selected from ISO/IEC 18529 was defined its purpose and outcomes as presented in Table 3 - Table 6. Again, some outcomes have been excluded in accordance to the identified requirements in relation to the characteristics specific to small organizations and the process defined by ISO/IEC 29110-4. ISO/IEC 29110-4 defines minimum software engineering processes for a small organization that develops a single application by a single work team. Thus, for example, as ISO/IEC 29110-4 does not consider the acquisition as a mandatory software engineering process in small organizations, it is inferred that it also should not be mandatory with respect to the usability process.

In total, 6 outcomes from ISO/IEC 18529 were excluded. In general, outcomes have been removed as they are not in the scope of the processes of small software organizations (such as the responsibility of installing and operating the system), or because they require more

advanced usability knowledge than staff of small organizations usually have. The justification for excluding the outcomes is presented in the column Justification (marked in red) in Table 3 – Table 6, presenting separately the outcomes with respect to each of the processes.

Table 3 - UP1 Specify stakeholder and organizational requirements

UP1	Specify stakeholder and organizational requirements	Justification for exclusion
Purpose	To establish the requirements of the organization and other interested parties for the system. This process takes full account of the needs, competencies and working environment of each relevant stakeholder in the system.	
Outcomes	Required performance of the new system regarding its operational and functional objectives.	
	Relevant statutory or legislative usability requirements, depending on the system domain.	
	Co-operation and communication between users and other relevant parties	
	The users' jobs (including the allocation of tasks, users' comfort, safety, health and motivation)	This outcome overlaps with the outcomes "Definition of the characteristics of the intended users" and "Definition and characterization of the tasks the users are to perform" from UP2.
	Task performance of the user when supported by the system	
	Work design, and social practices and structure	This outcome overlaps with the outcome "Definition and characterization of the tasks the users are to perform" from UP2.
	Feasibility of operation and maintenance	REQ 22 (Process should focus on engineering process)
	Objectives for the operation and/or use of the software and hardware components of the system.	

Table 4 - UP2 Understand and specify the context of use

UP2	Understand and specify the context of use	Justification
Purpose	To identify, clarify and record the characteristics of the stakeholders, their tasks and the social and physical environment in which the system will operate.	
Outcomes	Definition of the characteristics of the intended users.	
	Definition and characterization of the tasks the users are to perform.	
	Definition and characterization of the social and environment in which the system is used.	
	Definition and characterization of the technical environment in which the system is used.	
	The use of context analysis results in requirements to the interface design.	
	The context of use is available and used at all relevant points in the system development.	

Table 5 - UP3 Produce design solutions

UP3	Produce design solutions	Justification
Purpose	To create potential design solutions by drawing on established state-of-the-art practice, the experience and knowledge of the users and the results of the context of use analysis.	
Outcomes	Results of socio-technical context of use analysis are considered in the design.	
	User characteristics and needs will be taken into account in the purchasing of system components.	There are no mandatory or optional requirements related to the Acquisition processes in the Basic Profile of the ISO/IEC 29110 series; Nor are they expected to be defined in the next ISO/IEC 29110 series profiles [60].
	Results of the user analysis are taken into account in the design of the system.	
	Existing knowledge of best practice from socio-technical systems engineering, ergonomics, psychology.	REQ 19 (Little awareness on usability) Small enterprises typically does not have HR with expertise in usability
	Cognitive science and other relevant disciplines will be integrated into the system.	REQ 19 (Little awareness on usability) Small enterprises typically does not have HR with expertise in usability
	Communication between stakeholders is improved because the design decisions are more explicit.	
	The development team is able to explore several design concepts before they settle on one.	
	Feedback from end users and other stakeholders is incorporated in the design early in the development process.	
	It is possible to evaluate several iterations of a design and alternative designs.	
	The user's tasks are analyzed in relation to their, navigation, hierarchy and information architecture.	
	The design of all the user-related components of the system is specified, in terms of "look and feel".	
	The interface between the user and the software, hardware and organizational components of the system are designed.	
	User training and support will be developed.	ISO/IEC 29110-4 (Small enterprises generally are not responsible for the management, operation, integration and installation of the system.)

Table 6 - UP4 Evaluate designs against requirements

UP4	Evaluate designs against requirements	Justification
Purpose	To collect feedback on the developing design. This feedback will be collected from end users and other representative sources.	
Outcomes	Feedback is provided to improve the	

	design.	
	There is an assessment of whether stakeholder and organizational usability objectives have been achieved or not.	
	Long-term use of the system will be monitored	ISO/IEC 29110-4 (Small enterprises generally are not responsible for the management, operation, integration and installation of the system.)
	Potential problems and scope for improvements in: the technology, supporting material and social or physical environment.	
	Which design option best fits the functional and stakeholder and organizational requirements.	
	Feedback and further requirements from the users.	This outcome overlaps with the outcome "Feedback is provided to improve the design" from UP4.
	How well the system meets its organizational goals.	This outcome overlaps with the outcome "There is an assessment of whether stakeholder and organizational usability objectives have been achieved or not" from UP4.
	Guarantee that a particular design meets the human-centred requirements.	
	Conformity to international, national and/or statutory requirements, depending the system domain.	

3.2 Process assessment model

The UPCASE Process Assessment Model (PAM) is compliant with ISO/IEC 29110-3 [24] and contains the basis for collecting evidence and rating process capability. It contains two dimensions: The Process Dimension, which defines the set of processes that will be assessed (they are defined in the PRM) and the Capability Dimension, which defines the capabilities related to each process capability level and each process attribute. The capability dimension is not in the scope of this document. UPCASE's PAM contains a scope, indicators and a mapping for a Process Reference Model and a Measurement Framework [24]:

Scope: determines which processes will be assessed (at least one of the PRM) and which scale levels will be used to assess them.

Indicators: provide guidance on the interpretation of the process purposes and outcomes as defined in the PRM. They are sources of objective evidence used to support the assessors' judgment in rating process attributes and demonstrate the achievement of the process attributes within a capability level. There are two types of process performance indicators: Base Practice (BP) and Work Product (WP) indicators. Evidence of performance of the base practices and the presence of work products provide objective evidence of the achievement of the purpose of the process. A **base practice** is an activity that addresses the

purpose of a particular process. A set of base practices is associated with each process in the process dimension. The base practices are described at an abstract level, identifying “what” should be done without specifying “how”. The performance of a process produces **work products** that are identifiable and usable in achieving the purpose of the process.

Again, in accordance to the identified requirements and the process defined by ISO/IEC 29110-4, the practices of ISO/IEC 18529 have been removed or adapted to meet the requirements of the self-assessment method in this specific context. The adaptation of the practices aims at meeting requirements 6, 19, 20 and 25 identified in Section 2. Therefore, the practices are written in such a way that staff without SPI or usability knowledge can understand them and thus eliminating the need for external experts. To accomplish this, the use of complex nomenclature and concepts and jargons from the usability area domain was avoided. Furthermore, for each of the work products an example is provided illustrating is expected as result. In order to get a "light" process, practices that overlap each other or that seems over complicated for a small organization were removed.

The customization of the practices is presented in Table 7. In total, eight practices were excluded ISO/IEC 18529 (marked in red). The 16 practices selected from ISO/IEC 18529 were rewritten with the aim of making their understanding easier for assessors who are not experts in usability processes (REQ 20).

Table 7 – UPCASE Process practices

		ISO/IEC 18529 practices	Customized UPCASE Practices	Justification for exclusion
UP1	1	Clarify system goals	Identify system purpose	
		Analyze stakeholders	--	This practice overlaps with "Identify and document significant user attributes" practice. In addition, the basic profile of ISO/IEC 29110-4 does not have any practice related to the analysis of the roles of each stakeholder group besides the users. Characterization of the users is covered through UP2-Practice 6.
		Assess H&S risk	--	This practice has been removed in order to keep the process simple (REQ 19), and because it is contained in practice 6.
	2	Define system	Define system performance and behavior requirements desired by the user.	
		Generate requirements	--	This practice is performed in the context of the software engineering process (ISO/IEC 12207). Its output, however, should be used as input in the usability process, being necessary for the execution of practices 3 and 4.
	3	Set quality in use objectives	Define usability requirements.	
UP2	4	Identify and document user’s tasks	Identify and describe the user’s tasks of the	

			system	
	5	Identify and document significant user attributes	Identify user characteristics	
	6	Identify and document organizational environment	Identify social environment characteristics	
	7	Identify and document technical environment	Identify device characteristics	
	8	Identify and document physical environment	Identify physical environment characteristics	
		Allocate functions	--	This practice has been removed in order to keep the process simple (REQ 19), and because it is contained in practice 10.
UP3	9	Produce composite task model	Analyze user's tasks	
	10	Explore system design	Develop and analyze design options during interface development	
	11	Use existing knowledge to develop design solutions	Develop design solutions using existing knowledge	
	12	Specify system and use	Specify all user-related elements of the system	
	13	Develop prototypes	Prototype all user-related elements of the system	
	-	Develop user training	--	ISO/IEC 29110-4 (Small enterprises generally are not responsible for the management, operation, integration and installation of the system.)
		Develop user support	--	ISO/IEC 29110-4 (Small enterprises generally are not responsible for the management, operation, integration and installation of the system.)
UP4	14	Specify and validate context of evaluation	Prepare prototype/system evaluation	
		Evaluate early prototypes in order to define the requirements for the system		This practice has been removed in order to keep the process simple (REQ 19), and because it might be contained in practice 15.
	15	Evaluate prototypes and in order to improve the design	Evaluate prototypes and system to find usability problems	
	16	Evaluate the system in order to check that the stakeholder and organizational requirements have been met	Evaluate system against usability requirements	
	-	Evaluate the system in order to check that the required practice has	Evaluate system to find usability problems	This practice has been removed in order to keep the process simple (REQ 19), and because it might be contained in practice 15.

		been followed		
	-	Evaluate the system in use in order to ensure that it continues to meet organizational and user needs	--	ISO/IEC 29110-4 (Small enterprises generally are not responsible for the management, operation, integration and installation of the system)

In order to facilitate the understanding of its practices, ISO/IEC 18529 provides a description for each practice (Table 8). These descriptions have been adapted in order to attend REQ 20, to help assessors to better understand the UPCASE practices. In addition, examples of techniques for each practice were added to make it easier for the assessor to correctly identify practices within his/her.

Table 8 - Description of UPCASE practices and example of techniques

N Practice	UPCASE Practices	ISO/IEC 18529 Practices Description	Customized Practices Description	Example of Techniques
1	Identify system purpose	Describe the objectives which the user or user organisation wants to achieve through use of the system.	Identify and describe the purpose of the system, this is, the objective(s) that the user wants to achieve using the system.	Survey, brainstorming, interview, observation.
2	Define system performance and behavior requirements desired by the user.	Set and agree the required behaviour and performance of the system in terms of the total experience of the relevant stakeholders and/or the user organisation with the system. The total experience covers each aspect of a relevant stakeholder's relationship with the system and its context of use from its commissioning to its decommissioning.	Identify the stakeholder's requirements regarding the behavior and performance of the system. The requirements cover each aspect of the system related to its use and its interface in a context of use.	Survey, brainstorming, interview, observation.
3	Define usability requirements.	Generate and agree on measurable criteria for the required quality in use of the system	Define an explicitly statement for each usability requirements, regarding its effectiveness, efficiency and user satisfaction based on the context of use analysis. The statements should be measurable objectives.	Benchmarking with concurrent systems, synchronic analyzes, formal work analyses.
4	Identify and describe the user's tasks of the system	Describe the activities which users perform to achieve system goals.	Describe the tasks the users need perform in the system in order to achieve their goals.	Survey, interview, observation, formal work analysis, brainstorming with user's task, user's tasks modeling.
5	Identify user characteristics	Describe the relevant characteristics of the end-users of the system. This will include knowledge, language, physical capabilities, level of experience with job tasks and with relevant systems equipment, motivations in using the system, priorities, etc.	Identify relevant characteristics of the users, such as knowledge about the system domain, degree of literacy, physical capabilities, level of experience with the tasks and with the device he will use to interact with the system, motivations in using the system, etc	Survey, interview, observation.

6	Identify social environment characteristics	Describe the relevant social and organizational milieu, management structure, communications and organizational practices, etc.	Identify relevant social and organizational milieu, management structure, communications and organizational practices in the environment in which the system will be used.	Survey, observation, interview.
7	Identify device characteristics	Describe the relevant characteristics of any equipment to be used in the system or the context of use. Particular attention should be paid to the equipment with which the users will directly interact.	Identify relevant characteristics of the device with which the users will directly interact, such as memory and process capacity, ways of input and output data, screen size, etc.	Review platform documentation.
8	Identify physical environment characteristics	Describe the location, workplace equipment and ambient conditions and the implications for design. For example, lighting, noise levels, vibration, etc.	Identify relevant characteristics of the location, workplace equipment and ambient conditions and its implications for the system design, such as lighting, noise levels, vibration, heat, hazards, dimensions of working and living space.	Survey, observation, interview.
9	Analyze user's tasks	Develop a feasible model of the user's new tasks from existing knowledge of best practice, the requirements, context of use, allocation of function and design constraints for the system.	Analyze the user's tasks in terms of alternative navigation pathways and flowcharts and identifying the main system screens and constraints.	Conceptual model design, wireframes development, navigation definition, task hierarchy analysis, information architecture definition, card sorting.
10	Develop and analyze design options during interface development	Generate and analyze a range of design options for each aspect of the system related to its use and its effect on stakeholders.	Analyze a range of design options for each aspect of the system related to its use and its effect on stakeholders, such as definition of system controls, location and format of display components, use of colors, terminology, fonts, and wording of messages.	Wireframe development, sketches development, storyboarding, use case analysis.
11	Develop design solutions using existing knowledge	Apply relevant human science information to the design of the system. Include the stakeholder and organizational requirements, context of use, international standards, legislative requirements, existing patents, good practice, style guides and project standards etc. in the design.	Apply existing usability knowledge, such as stakeholder requirements, information about the context of use, international standards, usability good practice and style guides to the design of the system and is used to select the appropriate alternatives of design.	--

12	Specify all user-related elements of the system	Produce a design for the user-related components of the system. Produce description(s) of how the system will be used. Change design in the light of feedback from evaluations.	Specify the design of all the user-related components of the system. This specification is a description of how the components and the system will be used, such as the kind of systems controls will be used, location and format of display components, colors, terminology, fonts, wording of messages).	Wireframe and sketch development, storyboarding.
13	Prototype all user-related elements of the system	Make design solution(s) more concrete using simulations, models, mock-ups etc. Develop simulation or trial implementation of key aspects of the system for the purposes of testing with users or user representatives.	Refine design through the development of high-fidelity prototypes of all aspect of the system related to its use and its interface.	Prototype development.
14	Prepare prototype/system evaluation	Describe and check the conditions under which a system is tested or otherwise evaluated. Describe the relationship, and especially discrepancies, between the context of evaluation and the context of use.	Prepare and defined all arrangements necessary to evaluate the prototype or the system, such as definition of which evaluation method will be used, who will be the assessor, place, scripts, questionnaires, cameras and etc.	Prepare usability evaluation necessary materials, select participants.
15	Evaluate prototypes and system to find usability problems	Collect user input on the quality in use of the developing system. Present the results to the design team(s) in the most appropriate format.	Prototypes are evaluated against usability knowledge, style guides, standards, guidelines in order to find usability problems and verify if the required good practices have been followed.	Usability test with users, heuristic evaluation, cognitive walkthrough, key level stroke model evaluation.
16	Evaluate system against usability requirements	Test the developing or final system to ensure that it meets the requirements of the users, the tasks and the environment, as defined in its specification.	System is evaluated to ensure that it meets the requirements of the users, the tasks and the environment, as defined in its specification.	Usability test with users.

UPCASE method contains a set of suggestions of work products for each practice. The work products are based on the ISO/IEC 18529. This ISO/IEC technical report presents a list of the typical work products that originate from the implementation of usability processes. The work products from ISO/IEC 18529 were grouped by activity and adapted to suit the characteristics of small companies, i.e. work products considered complex for this type of company were omitted and others were adapted in order to facilitate their understanding by lay people in usability. This adaptation resulted in a compact list of work products that can be generated even by small companies, (Table 9). To make it easier for the assessor to correctly identify practices within his organization, when necessary, again, examples of work products for each practice were elaborated based on literature [62], [61], [64] and [65].

Table 9 – UPCASE Process work products

N Process	N Practice	Work products of ISO/IEC 18529	Customized work products	Example of Work product
UP1	1	-	Purpose(s) of the system	Example of system purpose: - Order food for home delivery
	2	Stakeholder/User Requirements Specification	A list of system performance and behavior requirements.	Examples of user performance and behavior requirements: - System should be easy to install, easy to read in lighting and noise environments, easy to use by person with low vision capability.
	3	A statement of the human-centred design goals	A list of usability requirements	Examples of usability requirements: Order a meal from the mobile application: - Maximum time to complete task: 2 minutes - Minimum percentage of users who can complete the task: 95% - All users must assess the system with at least 80 points in the SUS questionnaire.
UP2	4	Specification of the range of intended users, tasks and environments Task information	A list of user tasks and their characteristics and a list of use cases.	**List of user tasks:** - Register account - Login - Search restaurant - See restaurant menu - Add meals to cart - Order meal. **Example of task characteristics:**

Task	Order food
Frequency of use	Variable (daily, weekly, monthly)
Duration of the task	2-3 min
Task Flexibility	Ordered food (pizza, hamburger, hot-dog), amount of food portion, delivery address.
Alternative events	Delivery address do not exist
Physical and mental demands	Low
Task dependencies	User account in the system, internet access.
Task result	The restaurant receives the request for food delivery
Alternative events	Restaurant is closed at time.

Example of “use case”:

<table>
<tr>
<td></td>
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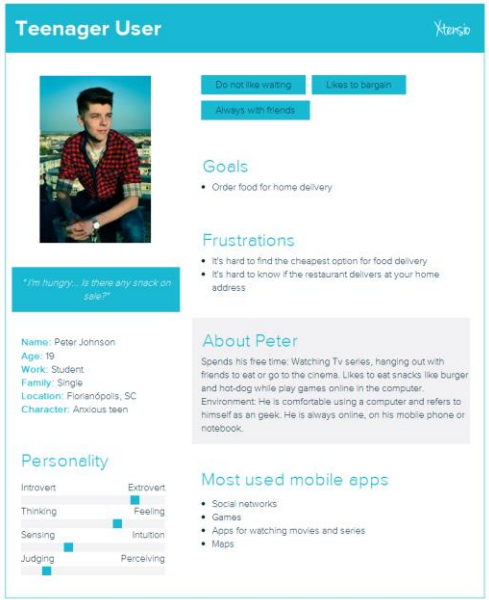
<td>
<table>
<tr><th colspan="2">Use case</th></tr>
<tr><td>Use Case Name:</td><td>Order Meal</td></tr>
<tr><td>Actors:</td><td>Customer</td></tr>
<tr><td>Description:</td><td>A customer accesses the Meal Delivery System using his mobile phone, searches for a specific restaurant, selects food items, and places an order for a meal to be delivered to a specified location.</td></tr>
<tr><td>Preconditions:</td><td>1. Customer is logged into Meal Delivery System.
2. Customer already found the intended restaurant.</td></tr>
<tr><td>Postconditions:</td><td>1. Meal order is stored in the system with a status of “accepted”.</td></tr>
<tr><td>Normal Flow:</td><td>1.0 Order a Meal
1. Customer asks to view the menu.
2. System displays menu of available food items.
3. Customer selects one or more food items from menu.
4. Customer indicates that meal order is complete.
5. System displays ordered menu items, individual prices, and total price and delivery charge.
6. Customer confirms meal order or requests to modify meal order (back to step 3).
7. Customer specifies payment method.
8. System confirms acceptance of the order.
9. System stores order in database and notify the restaurant Cafeteria Staff, sending the food item information.</td></tr>
<tr><td>Alternative Flows:</td><td>1.1 Order multiple meals (branch after step 4)
1. Customer asks to order another meal.
2. Return to step 2.</td></tr>
</table>
</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Stakeholder information
User information</td>
<td>User information, user profile, personas</td>
<td>Example of persona:</td>
</tr>
</table>

				 **Example of user profile:**

<table>
<tr><td></td><td></td><td></td><td></td><td>
<table>
<tr><th colspan="3">User profile</th></tr>
<tr><th>Personal attributes</th><th>Young</th><th>Adult</th></tr>
<tr><td>Age</td><td>15-30 years old</td><td>31-50 years old</td></tr>
<tr><td>Gender</td><td>50% male and 50% female</td><td>50% male and 50% female</td></tr>
<tr><td>Physical disabilities</td><td>May have some visual disability.</td><td>May have some visual disability.</td></tr>
<tr><td>Level of education</td><td>High school or graduation</td><td>High school or graduation</td></tr>
<tr><td>Competence in the use of the device</td><td>A lot of experience using mobile phones.</td><td>Have some experience using mobile phones.</td></tr>
<tr><td>Motivation</td><td>They have a lot of motivation to use the app.</td><td>They have a motivation to use the app.</td></tr>
</table>
</td></tr>
<tr><td></td><td>6</td><td>Organisational analysis
The sources from which the user and organisational requirements were derived</td><td>Description of social and organizational environment, management structure, communications and organizational practices or legislation.</td><td>Example of social environment characteristics:
<table>
<tr><th colspan="2">Organizational characteristics</th></tr>
<tr><td>Use in group</td><td>Yes</td></tr>
<tr><td>Assistance</td><td>No assistance will be provided while using the app, but the app provides a tutorial.</td></tr>
<tr><td>Interruptions</td><td>The user is subject to interruptions during the use of the system, having to pause the activity that is being carried out to resume later.</td></tr>
<tr><td>Discretion</td><td>May decide to call instead use the app, if the user think the app is too complicated or time consuming,</td></tr>
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</td></tr>
<tr><td></td><td>7</td><td>--</td><td>Analysis of the device characteristics</td><td>Example of device characteristics:</td></tr>
</table>

<table>
<tr>
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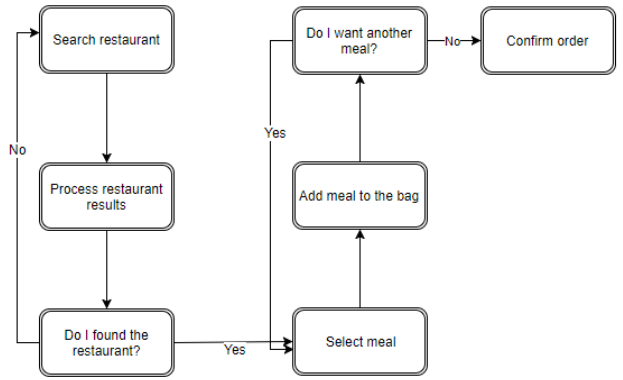
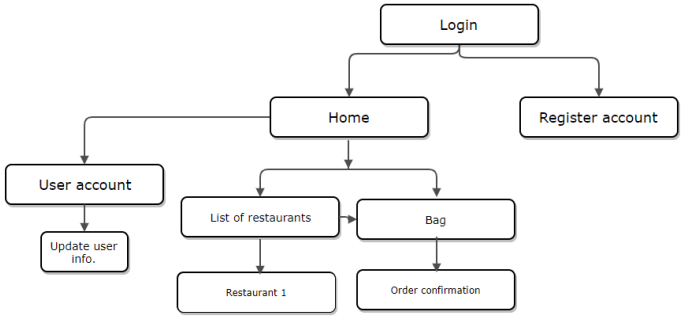
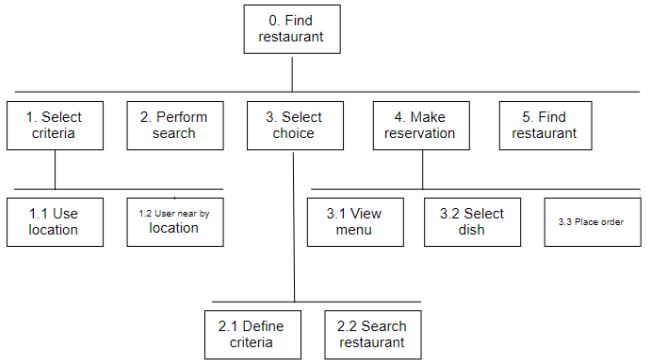
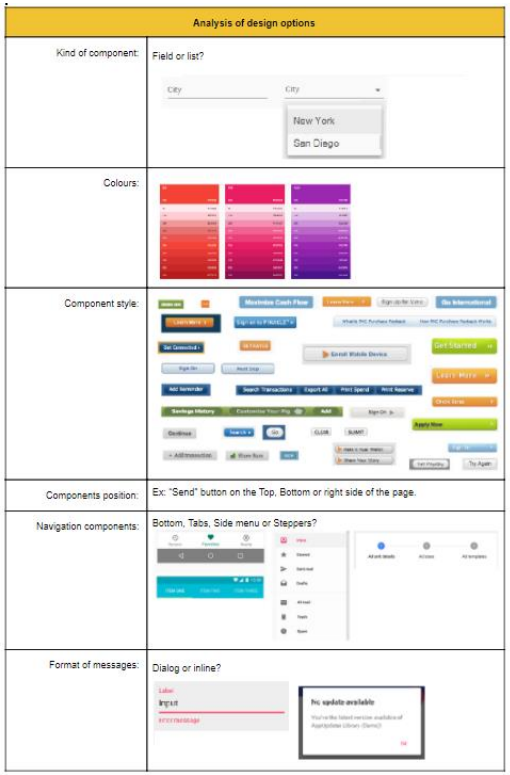
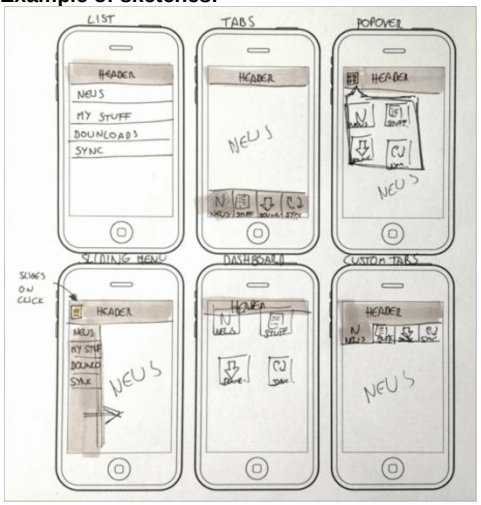
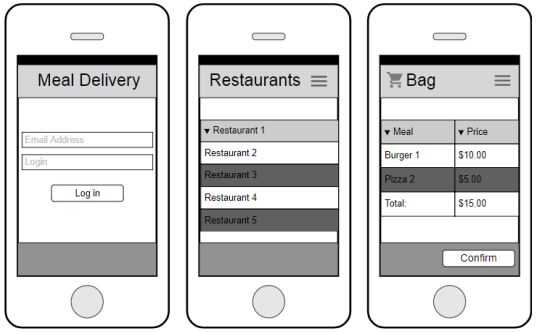
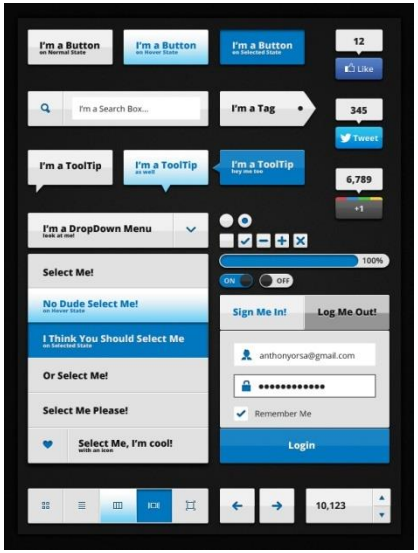
<td></td>
<td></td>
<td>
<table>
<tr><th colspan="2">Device characteristics</th></tr>
<tr><td>Device</td><td>Mobile phone</td></tr>
<tr><td>Platform</td><td>Android</td></tr>
<tr><td>Weight:</td><td>4 - 6 Ounces</td></tr>
<tr><td>Height:</td><td>5 - 7 Inches</td></tr>
<tr><td>Width:</td><td>2.5 - 3.5 Inches</td></tr>
<tr><td>Keyboard:</td><td>Touch Only</td></tr>
<tr><td>Display Size:</td><td>4.0 - 7.0 Inches</td></tr>
<tr><td>Front Camera MP:</td><td>4.00 - 10.00 Megapixels</td></tr>
<tr><td>Rear Camera MP:</td><td>9.00 - 16.00 Megapixels</td></tr>
<tr><td>Battery Standby:</td><td>200 -300 Hours</td></tr>
<tr><td>Internal Memory</td><td>8.00 - 32.00 GB</td></tr>
<tr><td>Features:</td><td>GPS, accelerometer</td></tr>
</table>
</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>--</td>
<td>Description of physical environment characteristics</td>
<td>Example of physical environment characteristics:
<table>
<tr><th colspan="2">Physical environment characteristics</th></tr>
<tr><td>Atmospheric conditions</td><td>The app may be used indoors.</td></tr>
<tr><td>Acoustic Environment</td><td>The app may be used in an environment that can be noisy.</td></tr>
<tr><td>Visual environment</td><td>The app may be used in an environment with sunlight or artificial lighting.</td></tr>
<tr><td>User Posture</td><td>The user may be sitting in a sofa or a chair</td></tr>
<tr><td>Health risks</td><td>The use of the app does not imply a risk to the health of the user.</td></tr>
</table>
</td>
</tr>
<tr>
<td>UP3</td>
<td>9</td>
<td>Task model
Worksystem design</td>
<td>Identification of main system screens, flowchart task, navigation</td>
<td>Example of task flowchart:</td>
</tr>
</table>

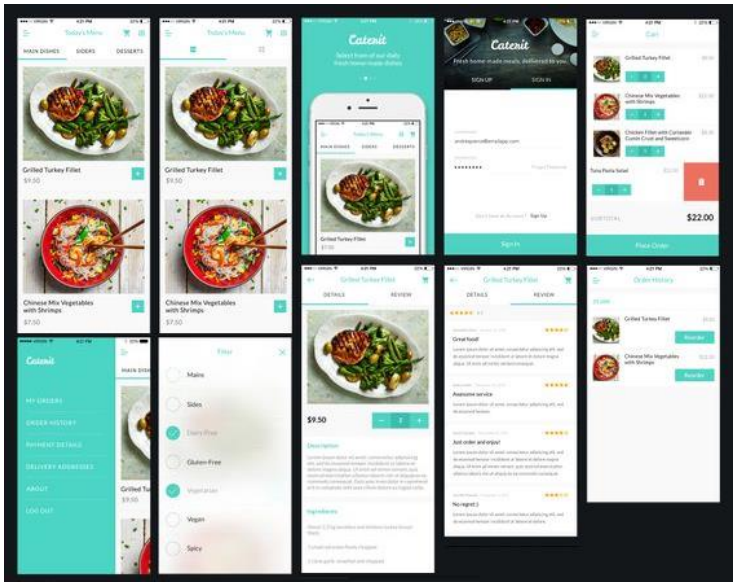
			diagram, task hierarchy.	 **Example of navigation diagram:**  **Example of task hierarchy analysis:**

				 0. Find restaurant 1. Select criteria 2. Perform search 3. Select choice 4. Make reservation 5. Find restaurant 1.1 Use location 1.2 User near by location 3.1 View menu 3.2 Select dish 3.3 Place order 2.1 Define criteria 2.2 Search restaurant

	10	--	Analysis of design options	
	11	List of standards used and how applied The sources of existing knowledge and the standards used, with an indication of how they have been incorporated (or why they have not been followed, if appropriate). Means of feedback and use of results in other design activities	--	--

		Evidence of revision in accordance with results of evaluations		
	12	User Interaction Specification	Wireframes, sketches, specification of system components behavior, storyboards.	**Example of sketches:**  **Example of wireframe:** 

	13	Dialogue detail Look and feel Layout and other UI issues Prototype(s) of parts and all of the system Simulations of specification	Definition of the “look and feel”, high fidelity prototypes, and detailed user interface design specification.	**Example of definition of the "look and feel":**  (Source: http://www.vectorarea.com/free-clean-blue-gloss-ui-kit-ui-kit) **Example of high fidelity prototype:**

				 (Source: https://br.pinterest.com/pin/323625923204182489/)
UP4	14	Which parts of the system are to be evaluated and how they are to be evaluated Context of evaluation Number of users taking part in testing, including evidence of adequacy of number of users and their representativeness of those identified in the context of use Survey plan Source of evaluation feedback Trial plans and records Testing and data collection methods, including evidence of appropriateness of these methods for the system and context use	Test script, test case, evaluation goals, metrics to be collected	**Where, who, when:** The test will be performed in organization meeting room, with 5 persons that represent the app user profile, Monday, 5 July at 2 pm. **Example of test script:** Welcome the participant and make him feel at ease; Reading the introduction script; Presentation and signature of the free and informed consent term; Raise demographic information (by interview or by requesting the completion of a background questionnaire); Ask the participant if he or she is already familiar with the device on which the test will be performed or if they wish to undergo a short training; If necessary, perform the training with the device before performing the test with it; Present and Deliver the list with the tasks to the participant; Participants perform the tasks (collect data in parallel for example via web cam / researcher notes) Apply the satisfaction questionnaire; Ask if the participant would like to make any further comments about the system;

				Thank the participant for participating in the test. **Example of test case: Order meal in the Food delivery app** Peter came home from football practice. He is tired and hungry, so he opens his food delivery app to find out if he has any meal deal at moment. He chooses the meal deal and asks to have it delivered to his house. Using the cell phone, access the app with the data from Peter's account and order a meal deal. **Example of evaluation goals:** Measure the extent with the system can be used with effectiveness, efficiency and satisfaction. **Example of metrics to be collected:** Time to complete a task; Number of errors committed; User degree of satisfaction.
	15	Usability and ergonomic defects Recommendations for improvement Video and audio tapes from trials User observation logs Measurements of ergonomic parameters A report of major and minor non-compliances and observations and an overall assessment Survey criteria Survey report	List of recommendation changes, list of usability problems found, violated heuristics, degree of severity of the usability problem.	**Example of usability problems:** - "The page has no title". - "The same symbol is used in two different icons". **Example of recommendations changes:** - "Add title in all pages". - "Use different symbols for icons with different functions". **Example of violated heuristics:** - "Visibility of System Status: The system do not inform the user if operation has finished or not. Severity: Major usability problem: important to fix, so should be given high priority." - "User control and freedom: The screen does not contain an option for the user to cancel the operation. Severity: Minor usability problem: fixing this should be given low priority."
	16	A clear pass/fail decision in relation to the requirements Revisions to requirements Full description of the system tested and its status Simulations of specification	A pass/fail decision regarding each requirement.	Example of a pass/fail decision: - Requirement: Maximum time to complete task: Pass. All test participants took less than 1,5 minutes. - Requirement: Minimum percentage of users who can complete the task: Fail. Only 80% of the test participants manage to complete de task. - Requirement: All users must assess the system with at least 80 points in the SUS questionnaire: Fail. Only 70% of the participants assess the system with more than 80 points in SUS questionnaire.

The process indicators were designed based on the practices, so that each one of them is associated with a process practice (Table **10**, column Indicators). The indicators are used to define the items of the assessment questionnaire to be used as script during the focus group meeting. In this respect, each indicator is written in such a way that it is easy to understand, even by person with a poor knowledge on usability process, in order to meet REQ 11.

In order to facilitate the accurate understanding of all the elements of the Assessment Method, a glossary is provided with the definition of the more technical wording in the area of usability (Appendix A). In addition to the definition, when necessary the glossary also presents examples of the concepts.

Table 10 **- Practices descriptions and indicators**

N Process	N Practice	Practice	Description	Indicator	Example of techniques	Example of work products
UP1	1	Identify system purpose	Identify and describe the purpose of the system, this is, the objective(s) that the user wants to achieve using the system.	Our team identifies and describes the purpose of the system.	Survey, brainstorming, interview, observation.	Purpose(s) of the system
	2	Define system performance and behavior requirements desired by the user.	Identify the stakeholder's requirements regarding the behavior and performance of the system. The requirements cover each aspect of the system related to its use and its interface in a context of use.	Our team identifies system performance and behavior requirements desired by the user.	Survey, brainstorming, interview, observation.	System performance and behavior requirements desired by the user.
	3	Define usability requirements.	Define an explicitly statement for each usability requirements, regarding its effectiveness, efficiency and user satisfaction based on the context of use analysis. The statements should be measurable objectives.	Our team defines explicit statements of usability requirements based on the context analysis.	Benchmarking with concurrent systems, synchronic analyzes formal work analyses.	A list of usability requirements
UP2	4	Identify and describe the user's tasks of the system	Describe the tasks the users need perform in the system in order to achieve their goals.	Our team identifies and describes the characteristics of the tasks the user performs in the system.	Survey, interview, observation, formal work analysis, brainstorming with user's task, user's tasks modeling.	A list of user tasks and their characteristics and a list of use cases.
	5	Identify user characteristics	Identify relevant characteristics of the users, such as knowledge about the system domain, degree of literacy, physical capabilities, level of experience with the tasks and with the device he will use to interact with the system, motivations in using the system, etc.	Our team identifies and describes the characteristics of the users.	Survey, interview, observation.	User information, user profile, personas
	6	Identify social environment characteristics	Identify relevant social and organizational milieu, management structure, communications and organizational practices in the environment in which the system will be used.	Our team identifies and describes the organizational and social characteristics regarding the environment in which the system will be use.	Survey, observation, interview.	Description of social and organizational environment, management structure, communications and organizational practices or legislation.

	7	Identify device characteristics	Identify relevant characteristics of the device with which the users will directly interact, such as memory and process capacity, ways of input and output data, screen size, etc.	Our team identifies and describes the characteristics of the device with which the users will interact to use the system.	Review platform documentation.	Analysis of the device characteristics
	8	Identify physical environment characteristics	Identify relevant characteristics of the location, workplace equipment and ambient conditions and its implications for the system design, such as lighting, noise levels, vibration, heat, hazards, dimensions of working and living space.	Our team describes the physical environment characteristics in which the system will be used.	Survey, observation, interview.	Description of physical environment characteristics
UP3	9	Analyze user's tasks	Analyze the user's tasks in terms of alternative navigation pathways and flowcharts and identifying the main system screens and constraints.	Our team analyzes the use cases in terms of its flow, navigation, main screens and constraints.	Conceptual model design, wireframes development, navigation definition, task hierarchy analysis, information architecture definition, card sorting.	Identification of main system screens, flowchart task, navigation diagram, task hierarchy.
	10	Develop and analyze design options during interface development	Analyze a range of design options for each aspect of the system related to its use and its effect on stakeholders, such as definition of system controls, location and format of display components, use of colors, terminology, fonts, and wording of messages.	Our team analyzes a range of design options for each aspect of the system related to its use and its interface during the system development.	Wireframe development, sketches development, storyboarding.	Analysis of design options
	11	Develop design solutions using existing knowledge	Applied existing usability knowledge, such as stakeholder requirements, information about the context of use, international standards, usability good practice and style guides to the design of the system and is used to select the appropriate alternatives of design.	Our team applies existing usability knowledge (such as stakeholder requirements, usability guidelines) in the system design.	--	**--**
	12	Specify all user-related elements of the system	Specified the design of all the user-related components of the system. This specification is a description of how the components and the system will be used, such as the kind of systems controls will be used, location and format of display components, colors, terminology, fonts, wording of messages).	Our team specified each aspect of the system related to its use and its interface.	Wireframe and sketch development, storyboarding.	Wireframes, sketches, specification of system components behavior, storyboards.
	13	Prototype all user-related elements of the system	Refine design through the development of high-fidelity prototypes of all aspect of the system related to its use and its interface.	Our team develops high-fidelity prototypes each component of the system interfaces.	Prototype development.	Definition of the “look and feel”, high fidelity prototypes, and detailed user interface design specification.

P4	14	Prepare prototype/system evaluation	Prepared and defined all arrangements necessary to evaluate the prototype or the system, such as definition of which evaluation method will be used, who will be the assessor, place, scripts, questionnaires, cameras and etc.	Our team prepares the prototypes and system evaluation.	Prepare usability evaluation necessary materials, select participants.	Test script, test case, evaluation goals, metrics to be collected.
	15	Evaluate prototypes and system to find usability problems	Prototypes are evaluated against usability knowledge, style guides, standards, guidelines in order to find usability problems and verify if the required good practices have been followed.	Our team evaluates the usability of the prototypes.	Usability test with users, heuristic evaluation, cognitive walkthrough, key level stroke model evaluation.	List of recommendation changes, list of usability problems found, violated heuristics, degree of severity of the usability problem.
	16	Evaluate system against usability requirements	System is evaluated to ensure that it meets the requirements of the users, the tasks and the environment, as defined in its specification.	Our team evaluates the system in order to check if it meets the usability requirements.	Usability test with users.	A pass/fail decision regarding each requirement

3.3 UPCASE MEASUREMENT FRAMEWORK

The measurement framework provides a schema to be used to characterize the capability of a process in relation to a reference model. The measurement framework of the UPCASE Method is based on ISO/IEC 29110 and it is composed of three elements: capability levels, process attributes and a rating scale.

Capability levels are used to determine the process capability. Capability levels group the process attributes and define an ordinal scale of capability that is applicable across all processes. Only two capability levels are used, as shown in Table 11.

Table 11 Process capability level description (Source: ISO/IEC TR 29110)

Capability level	Description
Level 0: Incomplete process	The process is not implemented or fails to achieve its process purpose. At this level there is little or no evidence of any systematic achievement of the process purpose.
Level ALPHA: Performed process	The implemented process achieves its process purpose.

Process attributes (PA) are measurable characteristics of process capability that are applicable to any process. Capability level 0 has no process attributes. Capability level ALPHA contains only one process attribute **PA 1 Performance**.

The process performance attribute is a measure of the extent to which the process purpose is achieved. As a result of full achievement of this attribute: - The process achieves its defined outcomes.

To measure the extent of achievement of a process attribute a **rating scale** is defined through an ordinal scale of measurement. The rating scale is composed of the categories:

N- Not achieved 0 to 15% achievement

P- Partially achieved >15% to 85% achievement

F- Fully achieved >85% to 100% achievement.

The process rating is generated as defined by ISO/IEC 15504 (and used by ISO/IEC TR 29110). The percentage of the process attribute achievement (PPAA) is calculated based on the process indicators rating, as follows:

PPAA = ($\sum process\ indicators\ rating$ /nºindicators*2)*100.

3.4 UPCASE ASSESSMENT PROCESS

The purpose of the assessment process is to systematically guide the process assessment activities. The assessment process of the UPCASE Method is based on the assessment process defined by ISO/IEC TR29110 and is composed by three components:

Phase: is a set of activities grouped in steps, presenting a logical or structured sequence.

Activity: is a stage of the process assessment that produces visible changes in the state of the product. The activity may have inputs, outputs, intermediate results, generically called work products. The activity implements procedures, rules and objectives to transform a product.

Work products: are the inputs and outputs of a process activity. They can be produced and consumed throughout the process and may have long life cycles, being created, accessed and modified.

3.4.1 Process assessment work products of the UPCASE Method

The UPCASE Method uses an adaptation of the work products defined by ISO/IEC TR 29110:

Inputs: The process assessment input defines the basic elements necessary to carry out the process assessment:

- **Purpose**: defines the reason for performing the assessment.
- **Scope**: defines the boundaries of the assessment, provided as part of the assessment input, encompassing the organizational limits of the assessment, the processes to be included, and the context within which the processes operate.
- **Resources and schedule**: are restrictions placed on the freedom of choice of the assessment team regarding the conduct of the assessment and the use of the assessment outputs.
- **Identities of team leader and participants**: the identity of the Process Assessment Model and the identity of the Process Reference Model used in the process assessment.
- **Approaches**: establishes the assessment approach: self-assessment or external assessment.
- **Assessor competencies**: are the criteria for competence of the assessor who is responsible by the assessment.
- **Questionnaire template**: defines indicators, examples of techniques and work products that support the judgment of the capability of an implemented process, as

well as a form to register the assessment results. UPCASE's questionnaire template is presented in Appendix B.

All assessment input information are provided by UPCASE method.

Outputs: The process assessment output consists of information about the performance of the assessment and its results, such as:

- **Date**: on which the assessment was carried out.
- **Assessment input**: the information used as input in the assessment process.
- **Identification of evidence**: the completed UPCASE assessment questionnaire, the document that presents evidences that demonstrate the result obtained with the assessment.
- **Assessment process used**: identifies which assessment process was used to perform the process assessment.
- **Process profile**: contains the set of the process attribute ratings for each assessed process. Each attribute rating represents a judgment by the assessor regarding the extent to which the attribute is achieved.

All outputs information are documented in UPCASE's process assessment report phase.

Roles and Responsibilities:

Another input for conducting a process assessment is the definition of Roles and Responsibilities. UPCASE defines three main roles for conducting an assessment:

- **Sponsor:** the representative of the enterprise that is being assessed.
- **Competent assessor (moderator):** responsible for ensuring that the assessment is performed in accordance with the UPCASE assessment process. This role is also responsible for conducting the assessment meeting, acting as a moderator.
- **Assessors that compose the assessment team:** along with the competent assessor are responsible for conducting the assessment.

Considering the context of small enterprises, in which a person may be responsible for various roles and responsibilities, when performing a process assessment, the same professional can assume the role of sponsor, competent assessor and assessor.

3.4.2 Phases and Activities of the UPCASE Method

Based on ISO/IEC 29110-3, the UPCASE assessment process is composed by four phases: Plan the assessment, Collect and Validate the data, Generate results and Report the assessment, as presented in **Error! Reference source not found.**. Activities that may be

automated by UPCASE Tool are visualized in yellow. The definition of the techniques and tools to perform each of these phases is based on good practices identified in literature.

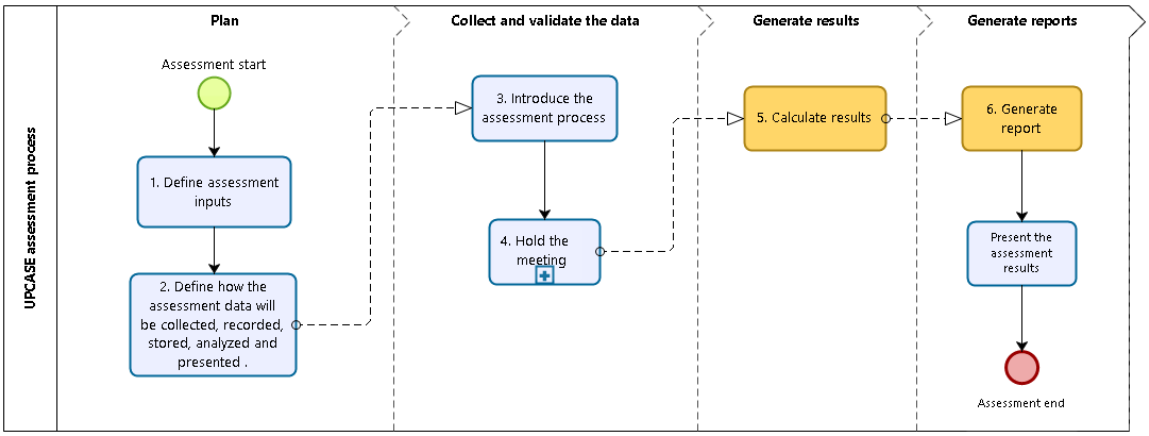


Figure 2 - Assessment process

3.4.2.1Plan the assessment

The assessment phase "Plan assessment" contains at least to two activities. When using UPCASE, some of the activities typically needed to plan the assessment are no longer needing to be performed by the assessment team, as their outputs are already defined by UPCASE Method, as shows Table 12. The column "Outputs defined by UPCASE" presents the outputs of the activity that do not need to be generated by the organization, since they are established by the assessment method. The column "Executed by the organization" displays the outputs of the activity that must be generated by the members of the organization.

Table 12 Plan the assessment – activities

Activities	Outputs defined by UPCASE	Outputs defined by the organization
1. Define the assessment inputs.	**Purpose**: assess de capability of the enterprise usability process. **Scope**: Includes the usability process 1, 2, 3 and 4 defined in UPCASE's PRM. **Approach**: Self-assessment. **Process Assessment Model**: UPCASE's PAM. **Assessment activities**: Defined by UPCASE. **Constraints** (the quantity and type of objective evidence to be examined in the assessment): One evidence (example of work product or technique) that the practice is performed. **Criteria for competence of the assessor:** Criteria are defined by UPCASE, as shown in Table 13. Roles and responsibilities are	Revised by the assessor

	defined by UPCASE, as shown in Table 13.	
		Resources and schedule: a) Availability of key resources and b) The maximum duration of the assessment. **Identities of team leader and participants.**
2. Define how the assessment data will be collected, recorded, stored, analyzed and presented with reference to the assessment tool.	As presented in Section 3.4 UPCASE assessment process.	Revised by the assessor

Table 13 UPCASE's Roles and Responsibilities

UPCASE Roles	UPCASE Responsibilities	Organization member
Sponsor	a)verify that the individual who is to take responsibility for conformity of the assessment is a competent assessor (following the definition of "competent assessor" as given by UPCASE); b) ensure that resources are made available to conduct the assessment; c) ensure that the assessment team has access to the relevant resources.	Some leadership position of the enterprise that realizes the need to assess the usability process, such as: - Project manager, - Development leader, - Design leader.
Competent assessor (Moderator)	a) confirm the sponsor's commitment to proceed with the assessment; b) ensure that the assessment is conducted in accordance with the assessment method; c) ensure that participants in the assessment are briefed on the purpose, scope and approach of the assessment; d) ensure that all members of the assessment team have knowledge and skills appropriate to their roles; e) ensure that all members of the assessment team have access to appropriate documented guidance on how to perform the defined assessment activities; f) ensure that all assessors are able to participate in the assessment meeting. g) carry out assigned activities associated with the assessment, e.g. detailed planning, data collection &validation and reporting;	Should be chosen by the sponsor. Preferably should be the professional with more knowledge about process assessment.
Assessors	a) provide examples of work products and techniques as evidence of the execution of the process. b) rate the processes attributes.	Assessors may be any professionals? who perform activities related to the usability process, such as: - Designers, - System analysts, - Testers.

Plan the assessment activities:

The activities of the Planning phase can be carried out during a meeting with the members of the organization which are responsible for the usability process, as defined in the inputs Roles and Responsibilities. During this meeting should be defined:

1) Resources and schedule: all resources necessary for carrying out the assessment, and any constraints, should be defined, including:

- **The availability of key resources**: such as location of the meeting, computer and projector to present the assessment tools, deck of cards to for consensus finding, members of the organization who have knowledge about the process being assessed.
- **The maximum duration of the assessment:** the maximum time that the enterprise may expend to perform the focus group, for example, a meeting of 2 hours or an entire afternoon.

2) Identities of team leader and participants: It is necessary to define which professionals will participate in the assessment and which paper each one will assimilate.

- **The identity of the competent assessor:** it should be defined who among the assessor will be the competent assessor.
- **The identity of the assessors:** it should be defined who among the employees will participate in the focus group.

3.4.2.2 Collect and validate the data

The assessment phase "Collect and validate the data" contains four activities (Table 14) that need to be performed by the assessment team.

Table 14 Collect and validate the data - activities

Activities	Outputs defined by the organization
Brief the assessment team	1) Briefing the assessment
Collect evidence of process capability for each process within the scope.	2) Assessment meeting with assessment poker:
Record and maintain references to the evidence	2.7 The moderator completes the response of the item in the questionnaire.
Validate the data	2.5 The moderator requests examples of work products that demonstrate the accomplishment of the practice indicator.

Data collection and validation activities:

The four activities that must be performed by the assessor are carried out during a

briefing and a focus group meeting.

1) Briefing the assessment: The moderator presents the purpose of the process assessment that will be carry out. He presents the focus group and assessment poker techniques, as well as the inputs and outputs of the assessment. At the end of the briefing the moderator should ensure that the assessment team understood the proposed assessment approach, the inputs and outputs, as well as, how to use the UPCASE Method. UPCASE method provides a script for the Briefing in Appendix C.

2) Assessment meeting with Assessment Poker:

Data collection and validation are performed during an assessment meeting with the assessment participants, as defined in the planning phase. The assessment meeting is divided in the following sub-activities, as defined in Figure 3. To conduct the Assessment meeting,

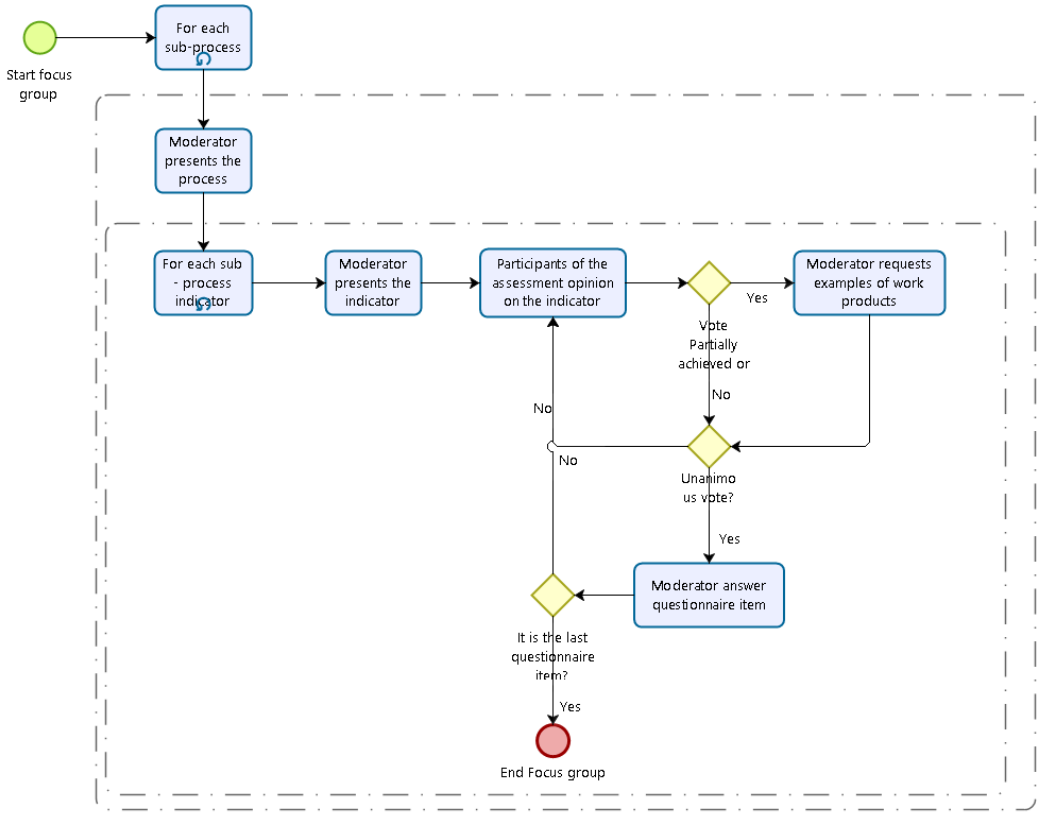


Figure 3 Assessment meeting activities

UPCASE Method provides a questionnaire that contains the items that should be assessed for each usability sub-process, as well as the description of each of them with examples of work products and techniques. The questionnaire is presented in Appendix B and is available online in the link match.inf.ufsc.br:90/upcase/ in English and Brazilian Portuguese. UPCASE also provides a deck to be used in the Assessment poker (available in Appendix D) will be necessary.

Description of the Assessment Poker process:

1. The moderator presents the usability sub-process, along with its purpose and outcomes.

2. For each questionnaire item:

2.1 The moderator reads the questionnaire item, along with its description, work products and techniques.

2.2 If any concept is not understood, the moderator checks the concept in the glossary.

2.3 After the questionnaire item is clearly understood by all participants, the moderator asks them to give their opinion about the item that was read.

2.4 The participant must present the card of the deck that represents his opinion: "Not achieved", "Partially achieved" or "Fully achieved". The participant must inform "Not achieved" if he considers that the organization does not perform this practice, "Partially achieved", if he considers that the organization accomplishes this practice, but it is not always performed; and "Fully achieved", if he agrees that the organized perform the practice described in the item. All participants must present their cards at the same time.

2.5 If any participant opines with "Partially achieved" or "Fully achieved", the moderator should request an example of work products that demonstrate the achievement of the indicator.

2.6 As long as the participants' opinions on the item do not achieve a unanimous result, step 2.2.4 is repeated.

2.7 The moderator completes the response of the item in the UPCASE questionnaire.

Why hold an assessment meeting, in the form of a focus group, and use "Assessment" poker for collecting data:

Most self-assessment methods use surveys for data collection, only a few use interviews, workshops or focus group meetings [56]. Despite the wide adoption of surveys as a method for data collection, it does not come without shortcomings. Using questionnaires to perform a survey may lead to unreliable responses (if the subject misinterprets a question) or/and to a lack of completeness. Further than that, questionnaires turn difficulty the manipulation of entries, which means, that is no way to interact with the respondents in order to asking for further explanations on the answer he gave, and there are no ways to confirm that he understood the questions adequately.

On the other hand, the use of interviews for collecting data may solve the issues regarding the use of questionnaires method. However, interviews also present some disadvantages, such as high cost (as requires people to conduct the interviews) and the collection of a small sample of data (as the size of the sample is limited to the size of interviewing staff) [66].

In this context, in UPCASE's assessment process was chosen to use the Focus Group method. Focus group is a group interview that focuses upon a particular issue, product, service or topic and encompasses the need for interactive discussion amongst participants [67]. The persons chosen to participate in the focus group meeting need to have certain characteristics in common that relate to the topic being discussed. During the meeting, the participants are encouraged to discuss and share their points of view without any pressure to reach a consensus [68].

Focus groups have some advantages over other methods for collecting data:

- It allows the discussion of each one of the questions among a group of people. In this way it is possible to reach at a consensual conclusion about each question discussed, and thus increase the accuracy of the responses collected.
- Eliminates the need for a later step to validate participants' response, as this occurs during the meeting.
- It is more efficient because it allows obtaining the opinion of a larger number of people in a shorter period of time.
- Prevents the moderator from having to interview the same person again to confirm information provided by another respondent.
- A single participant may not know how to answer questions about all processes, so the focus group avoids wasting time in interviewing him about issues he does not know how to answer.

On the other hand, the realization of a focus groups meeting is not without shortcomings, as group interactions may lead to a highly productive discussion as interviewees respond to your questions and evaluate points made by the group. Thus, there may emerge a group effect where certain participant try to dominate the interview whilst others may feel inhibited. This may result in some participants publicly agreeing with the views of others, whilst privately disagreeing. As a consequence, a reported consensus may, be an idea that nobody really endorses or disagrees with [66], [69].

To mitigate the risk that some participants do not opine or be embarrassed to give their true opinion in front of colleagues or boss, UPCASE proposes to perform the focus group in conjunction with an adaptation of the Planning poker, a consensus-based technique for estimating effort.

Planning poker is a popular technique based on the Wideband Delphi [70], which aims at increasing the precision of estimating the effort of tasks. This technique was created to solve two common problems during the realization of the estimates: estimates were taking a long time, and not the whole team was involved [71]. Generally, the decision about the fulfillment of an indicator is only under the responsibility of the leading assessor. However, considering RE7 6, an assessor may not have enough knowledge to judge whether an indicator is attended, in case he obtains conflicting data in data collection. The use of planning poker in the assessment reduces the importance of the judgment of the leading assessor by distributing it throughout the whole assessment team. This happens as Planning Poker allows the assessor team to reach a consensus about the attendance of each indicator. In a Planning Poker meting the moderator reads a story (or indicator). There is a discussion clarifying the story as necessary. Each participant chooses a card that represents their estimate. Once all participants have chosen their estimate, they turn over all the cards. If there is agreement, no discussion is necessary, and the estimate is recorded. If there is disagreement in the estimates, the team discusses their different estimates and tries to get to consensus [71].

3.4.2.3Generate results

The assessment phase "Generate Results" contains two activities (Table 15). The first, Derivation of assessment results, one may be performed by the assessment team or may be automatically generated by UPCASE questionnaire provided at link match.inf.ufsc.br:90/upcase/. The second activity, Report assessment, should be performed by the members of the organization using the template provided by the UPCASE.

Table 15 Generate results - activities

Activities	Outputs defined by UPCASE	Outputs defined by the organization
1)Derivation of the assessment results	X	X
2)Report the assessment	UPCASE defines a report template.	a) Prepare the assessment report. b) Present the assessment results to the sponsor.

Generate results activities:

The activities of the "Generate results" phase must be carried after the assessment meeting, by any of the participants. In this phase the following activities are expected to be performed:

1) Derivation of assessment results

The derivation of the process assessment results is based on the answers of the

completed UPCASE questionnaire. The result of the assessment determines the enterprise usability process profile. The process profile contains a set of the process attribute ratings for each assessed sub-process, as well as the capability level of the usability process as a whole. Appendix E presents an example of a hypothetical assessment results derivation.

The usability process capability Level and usability process profile are derived from the process attribute ratings, following the steps:

1.) Calculate usability sub-process percentage of achievement based (USPA) on the indicators ratings:

USPA= $((\sum sub - processindicatorsratings)$ /nºindicators*2)*100.

1.2) Calculate sub-process attribute capability rating:

The sub-process attribute rating is calculated based on its achievement percentage, as defined in ISO/IEC TR 29110.

Table 16 Attribute rating according to the achievement percentage

Attribute rating	Achievement percentage
N- Not achieved	0 to 15% achievement
P- Partially achieved	>15% to 85% achievement
F- Fully achieved	>86% to 100% achievement

1.3) Calculate usability process percentage of achievement (UPPA) based on the indicators ratings: The usability process capability level is calculated based on its sub-process capability rating:

UPPA= $((\sum usabilityprocessindicatorsratings)$ /nºindicators*2)*100.

Usability process attribute rating is calculated based on its Percentage of achievement, as defined in step 2.

2) Report the assessment:

In this activity a report with the information of the assessment is developed, as well as the results are presented for the interested parties.

2.2) Prepare the assessment report: The assessment findings are summarized, highlighting the process profile, observed strengths and weaknesses and potential improvement actions. The report can be generated automatically if the evaluation was carried out using the online evaluation questionnaire (available at match.inf.ufsc.br:90/upcase/). Otherwise, the report may be developed by any member of the organization that participated in the assessment. In this case, the Report template presented in Appendix F can be used.

The report shall contain at least the following information:

- Assessment date

- Assessment moderator

- Assessment participants

- Usability process rating

- Rating of each usability sub-process

- Legend of the ratings

- Strengths found in the assessment (e.g.: practices of the usability process that the organization already performs and that must continue being carried out).

- Points that can be improved (e.g.: practices of the usability process that the organization does not yet perform or that it does not perform consistently or adequately).

2.3) Present the assessment results to the sponsor: The assessment results are presented to the interested parties (e.g. management, practitioners, etc.) during a meeting. The presentation can be made by any member of the organization that participated in the process assessment. All the information contained in the assessment report can be presented. The emphasis of the presentation should not be on the process rating, but rather on the items identified as opportunities for improvement.

Appendix A - Glossary

Table 17 - Glossary

Concept	Definition	Reference
Process	A set of interrelated activities, which transform inputs into outputs.	ISO/IEC 18529
Practice	A technical or management activity that contributes to the creation of the output (work products) of a process or enhances the capability of a process.	ISO/IEC 18529
Work product	A document, piece of information, product or other item which acts as input to or output from a process	ISO/IEC 18529
Indicator	Sources of objective evidence used to support the assessors' judgment in rating process attributes	ISO/IEC 29110
Usability requirement	Usability requirements define the intended objectives and context of use and specifies levels of measures and criteria for effectiveness, efficiency and satisfaction for the product under development	ISO/IEC 9142-11
Use case	A use case is all the ways of using a system to achieve a particular goal for a particular user. Taken together the set of all the use cases gives you all of the useful ways to use the system.	(Jacobson, I., 2011)
User characteristic	Is a general description of a user group of specific software. Typically includes characteristics that may influence design choices, such as: demographic characteristics, education, language, computer expertise, domain experience, motivation, or expectations.	(Human Factors International, 2014).
Social environment characteristic	Describe the relevant social milieu, management structure, communications and organizational practices. At a lower level it describe the structure of the organization, the way people use the system, individually and in groups, the availability of assistance and the frequency of interruptions, political and interpersonal factors, degree of freedom, influence in decision-making.	(Maguire, M., 2001) ISO/IEC 18529
Physical environment characteristic	Characteristics of the physical environment in which the users will interact with the system, such as the physical environment can have a profound effect on the usability of a product. Bad lighting or loud noise in the place may prevent the users from receiving feedback from the system.	(Maguire, M., 2001)
Task characteristic	Overview of a given task outlining its characteristics that impact usable design, including importance, frequency, sequence, dependency and flow, criticality.	(Human Factors International, 2014).
Design options	Design options are artifacts that present design alternatives for each aspect of the system related to its use, such as the definition of system controls, location and format of display components, use of colors, terminology, fonts, and wording of messages.	ISO/IEC 18529
Prototype	Representation of all or part of an interactive system that, although limited in some way, can be used for analysis, design and evaluation.	ISO/IEC 9241-110
High-fidelity prototype	Representation of all or part of an interactive system that is typically quite close to the final product, with all (or almost all) elements of the screen detailed and refined in relation to their positioning, size, color and shape.	(Usability First, 2015)
Low-fidelity prototype	Representation of all or part of an interactive system that	(Human Factors International,

	is typically made in paper, slides, or other non-interactive mock-ups of an interface developed early in design. Typically, do not contain too much detail about the look and feel of the screen elements.	2014).
Usability problem	An aspect of the system which makes it unpleasant, inefficient, onerous or impossible for the user to achieve their goals in typical usage situations.	ISO/IEC 9241-110
Stakeholder	Individual or organization having a right, share, claim or interest in a system or in its possession of characteristics that meet their needs and expectations.	ISO/IEC 9241-110
Context of use	Evolves the users, tasks, technical (hardware, software and materials), and the physical and social environments in which a product is used.	ISO/IEC 9241-110
Effectiveness	Accuracy and completeness with which users achieve specified goals.	ISO/IEC 9241-110
Efficiency	Represents the amount of effort or resources expended in relation to the accuracy and completeness with which users achieve goals.	ISO/IEC 9241-110
User satisfaction	The freedom from discomfort and positive attitudes towards the use of the product.	ISO/IEC 9241-110
Usability	Extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use	ISO/IEC 9241-110
User task	Activity required to the user achieving a certain goal in the system.	ISO/IEC 9241-110
Flowchart	Visual way of representing a task or procedure. Steps of a process are represented in boxes and flow is represented by arrows connecting the boxes. Input and output are typically represented in skewed parallelograms, and decision points are usually represented with diamonds.	(Usability First, 2015)
Style guide	Reference that establishes the look-and-feel of a user interface by defining the its standards and conventions. It usually includes the principles that guide the design of the interface, graphic layout grids, exact size and spacing of elements in the interface, fonts, colors, interactive behavior and standard text messages (such as error messages).	(Usability First, 2015)
Heuristic evaluation	Technique for finding usability problems in a user interface. A small number of trained evaluators (typically 3 to 5) individually inspect a user interface by applying a set of “heuristics”, broad guidelines that are generally relevant. They then combine their results and rank the importance of each problem to prioritize fixing each problem.	(Usability First, 2015)
Cognitive walkthrough	Technique to evaluate a user interface based on stepping through common tasks that a user would need to perform and evaluating the user’s ability to perform each step (e.g., “How many users will click this button for task A? What happens when they do?”). This approach is intended specially to help understand the usability of a system for first-time or infrequent users, that is, for users in an exploratory learning mode.	(Usability First, 2015)
Key level stroke model	Technique to predict how long it will take a user to accomplish a task without errors using a system. KLM defines an estimated time to execute each operator (typing a character, pointing with the mouse, clicking the mouse, etc.). KLM estimate the task execution time by	(Card et al., 1980)

	listing the sequence operators required to perform a user task and then summing the times of the individual operators.	
Brainstorming	Brainstorming is a method for generating group creativity. A group of people come together and focus on a problem or proposal. There are two phases of the activity. The first phase generates ideas, the second phase evaluates them.	(Usability Net , 2006)
Interview	One-on-one interactions between end-users and usability analysts, designed to elicit the users' conceptual model of a system, the tasks and task flows, or other issues related to design	(Human Factors International, 2014).
Observation	Method in each an investigator view user as they work in a field study, and taking notes on the activity that takes place. Observation may be either direct, where the investigator is actually present during the task, or indirect, where the task is viewed by some other means such as through use of a video recorder.	(Preece, J. et al., 1994)
Conceptual model design	Is a model constructed by the users in their mind to understand the working or the structure of objects, based on their mental model and previous experience, to speed up their understanding. Humans establish mental models of how things work, or how they would behave in a particular situation.	(Human Factors International, 2014).
Wireframe	A wireframe is a two-dimensional illustration of a screen interface that specifically focuses on space allocation and prioritization of content, functionalities available, and intended behaviors. For these reasons, wireframes typically do not include any styling, color, or graphics.	(Usability Gov., 2017)
Information architecture	Is an activity of the conceptual design stage associated with defining the system content. Includes the processes of defining the system screens hierarchies, content organization, and labeling schemes for all types of menu systems, and the techniques for creating and evaluating them	(Human Factors International, 2014).
Navigation pathway	Based on task design and information architecture definitions developed in conceptual design, navigation design marks the first formal step of design. It includes the development of wire frames and prototypes to test the design structure and aesthetic. A set of core navigation screens are designed, tested, and iterated during this stage to ensure that the user interface structure is sound before investing in detailed design.	(Human Factors International, 2014).
Task hierarchy analysis	Activity in which the hierarchy of the user tasks is analyzed. The task hierarchy is an organization of elements that, according to prerequisite relationships, describes the path users must take to achieve any single behavior that appears higher in the hierarchy. Thus, in a hierarchical analysis, the designer decomposes a task from top to bottom, thereby, showing the hierarchical relationship amongst the tasks in a bottom up order.	(Stanley, T., 1999)
Sketch	Simply or hastily drawing giving the essential features of the system without the details. It excludes the level of detail that goes into the final product.	(Human Factors International, 2014).
Card sorting	A technique to investigate how users tend to group things. The users are given a set of cards containing individual item names and are told to sort them into related piles and label the groups. Card sorting provides insight into the user's mental model and suggests the	(Human Factors International, 2014).

	structure and placement of items on a system.	
Storyboarding	A series of illustrations that represent a user task, such as the steps necessaries to perform a task using a system.	(Usability First, 2015)

APPENDIX B - Assessment Questionnaire Template

N	Indicator	N	P	F	Description
1	Our team identifies the purpose of the system.				Identify and describe the purpose of the system, this is, the objective(s) that the user wants to achieve using the system.
2	Our team identifies stakeholders' expectations regarding the performance and behavior of the system.				Identify the stakeholder's requirements regarding the behavior and performance of the system. The requirements cover each aspect of the system related to its use and its interface in a context of use.
3	Our team defines explicit statements of usability requirements based on the context analysis.				Define an explicitly statement for each usability requirements, regarding its effectiveness, efficiency and user satisfaction based on the context of use analysis. The statements should be measurable objectives.
4	Our team identifies and describes the characteristics of the tasks the user performs in the system.				Describe the tasks the users need perform in the system in order to achieve their goals.
5	Our team identifies the characteristics of the users.				Identify relevant characteristics of the users, such as knowledge about the system domain, degree of literacy, physical capabilities, level of experience with the tasks and with the device he will use to interact with the system, motivations in using the system, etc.
6	Our team identifies the organizational and social characteristics regarding the environment in which the system will be use.				Identify relevant social and organizational milieu, management structure, communications and organizational practices in the environment in which the system will be used.
7	Our team identifies the characteristics of the device with which the users will interact to use the system.				Identify relevant characteristics of the device with which the users will directly interact, such as memory and process capacity, ways of input and output data, screen size, etc.
8	Our team identifies the physical environment characteristics in which the system will be use.				Identify relevant characteristics of the location, workplace equipment and ambient conditions and its implications for the system design, such as lighting, noise levels, vibration, heat, hazards, dimensions of working and living space.
9	Our team analyzes the use cases in terms of its flow, navigation, main screens and constraints.				Analyze the user's tasks in terms of alternative navigation pathways and flowcharts and identifying the main system screens and constraints.
10	Our team analyzes a range of design options for each aspect of the system related to its use and its interface.				Analyze a range of design options for each aspect of the system related to its use and its effect on stakeholders, such as definition of system controls, location and format of display components, use of colors,

					terminology, fonts, and wording of messages.
11	Our team applies existing usability knowledge (such as stakeholder requirements, usability guidelines) in the system design.				Applied existing usability knowledge, such as stakeholder requirements, information about the context of use, international standards, usability good practice and style guides to the design of the system and is used to select the appropriate alternatives of design.
12	Our team specifies each aspect of the system related to its use and its interface.				Specified the design of all the user-related components of the system. This specification is a description of how the components and the system will be used, such as the kind of systems controls will be used, location and format of display components, colors, terminology, fonts, wording of messages).
13	Our team prototypes high-fidelity each component of the system interfaces.				Refine design through the development of high-fidelity prototypes of all aspect of the system related to its use and its interface.
14	Our team plans the prototypes and system evaluation.				Prepared and defined all arrangements necessary to evaluate the prototype or the system, such as definition of which evaluation method will be used, who will be the assessor, place, scripts, questionnaires, cameras and etc.
15	Our team evaluates the usability of the prototypes.				Prototypes are evaluated against usability knowledge, style guides, standards, guidelines in order to find usability problems and verify if the required good practices has been followed.
16	Our team evaluates the system in order to check if it meets the usability requirements.				System is evaluated to ensure that it meets the requirements of the users, the tasks and the environment, as defined in its specification.

APPENDIX C - ASSESSMENT BRIEFING SCRIPT

1) Welcome participants to the meeting.

2) Present the purpose of the assessment:

"The purpose of this meeting is to assess the usability process of the organization in order to identify its strengths and weaknesses, and in this way to be able to initiate a program to improve our process."

3) Explain how the assessment will be performed:

"To perform the assessment, we will use the UPCASE method, which has an online tool, which will be used to conduct this assessment and generate the results.

The assessment should not last longer than one hour. The assessment of the process consists in making an "Assessment poker", which will be carried out as follows:

I will act as moderator, I will read the description of each usability sub-process. I will then read each of the items in the questionnaire regarding this sub-process. I will also present the descriptions and examples of work product and techniques that can be used to generate them. We will reflect if we think that the item is:

Not achieved (if we think that the item that was read is not carried out in our projects).

Partially achieved (if we think that the item is carried out sometimes in our projects).

Fully achieved (if we think that the item is always carried out in our projects).

Then we will all present at the same time the card that contains our opinion on the item.

If there are different answers, each participant must justify his / her choice. Then the cards are played again.

This process must be repeated, until it reaches consensus on the answers.

If the consensus is that the item is not achieved, the answer is marked on the questionnaire and we proceed to the next item in the questionnaire.

If the consensus is reached and the item is partially achieved or fully achieved, we should provide an example of activity that confirms the item is achieved.

If an example is provided, then the questionnaire item can be marked based on the voting, otherwise the item should be marked as "Not achieved".

After performing this process for all 16 items of the questionnaire, the UPCASE Tool will generate the score of our usability process, as well as elicit the points that can be improved."

Confirm that all participants understood the purpose of the assessment and how it will be carried out.
Give a card of "Not achieved", "Partially achieved" and "Fully achieved" for each participant.

APPENDIX D - ASSESSMENT POKER DECK OF CARDS

Figure 4 - Assessment poker cards

APPENDIX E - EXAMPLE OF UPCASE USE

Example of completed UPCASE questionnaire		
Sub-process	**Indicators**	Rating (**0-Not achieved, 1-Partially achieved, 2-Fully achieved**)
1 - Context of use	Our team identifies the purpose of the system.	**1-partially achieved**
	Our team identifies stakeholders' expectations regarding the performance and behavior of the system.	**2-fully achieved**
	Our team defines explicit statements of usability requirements based on the context analysis.	**1-partially achieved**
2 - User requirements	Our team identifies and describes the characteristics of the tasks the user performs in the system.	**2-fully achieved**
	Our team identifies the characteristics of the users.	**0-Not achieved**
	Our team identifies the organizational and social characteristics regarding the environment in which the system will be use.	**2-fully achieved**
	Our team identifies the characteristics of the device with which the users will interact to use the system.	**1-partially achieved**
	Our team identifies the physical environment characteristics in which the system will be use.	**1-partially achieved**
3 - Produce design solutions	Our team analyzes the use cases in terms of its flow, navigation, main screens and constraints.	**2-fully achieved**
	Our team analyzes a range of design options for each aspect of the system related to its use and its interface.	**1-Not achieved**
	Our team applies existing usability knowledge (such as stakeholder requirements, usability guidelines) in the system design.	**2-fully achieved**
	Our team specifies each aspect of the system related to its use and its interface.	**2-partially achieved**
	Our team prototypes high-fidelity each component of the system interfaces.	**2-partially achieved**
4 - Evaluate designs against requirements	Our team plans the prototypes and system evaluation.	**0-Not achieved**
	Our team evaluates the usability of the prototypes.	**2-fully achieved**
	Our team evaluates the system in order to check if it meets the requirements.	**1-partially achieved**

Assessment results		
Sub-process	**Score**	**Rating**
1 - Context of use	4 points (from a total of 6 points = 66,6% of achievement)	P - Partially achieved
2 - User requirements	6 points (from a total of 10 points = 60% of achievement)	P - Partially achieved
3 - Produce design solutions	9 points (from a total of 10 points = 90% of achievement)	F - Fully achieved
4 - Evaluate designs against requirements	3 points (from a total of 6 points = 50% of achievement)	P - Partially achieved
Total score of the usability process	22 points (from a total of 32 points = 68,75% of achievement)	P - Partially achieved

List of points that can be improved with the indicators that can be improved in the sub-processes that were classified with N or P:

- Identify the purpose of the system.
- Define explicit statements of usability requirements based on the context analysis.
- Identify the characteristics of the users.
- Identify the characteristics of the device with which the users will interact to use the system.
- Identify the physical environment characteristics in which the system will be use.
- Analyze a range of design options for each aspect of the system related to its use and its interface.
- Plan the prototypes and system evaluation.
- Evaluate the system in order to check if it meets the requirements.

APPENDIX F - ASSESSMENT REPORT TEMPLATE

Usability Process Assessment Report	
Assessment date:	
Assessment meeting moderator:	
Assessment meeting participants:	
Usability process rating	
Usability sub-process rating	
UP1. Specify stakeholder and user	
UP2. Understand and specify the context of	
UP3. Produce design solutions:	
UP4. Evaluate designs against	
Legend: 0 - 15 points: Not achieved. 16 - 85 points: Partially achieved. 86 - 100: Fully	
Strength points:	
Points to be improved:	

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