A Scrum-Based Development Process to Support Co-creation with Elders in the eHealth Domain

Chapter *in* Lecture Notes in Computer Science · November 2020

DOI: 10.1007/978-3-030-64266-2_6

4 authors:

Jose María Barambones
Universidad Politécnica de Madrid
8 PUBLICATIONS **36** CITATIONS
SEE PROFILE

Cristian Moral
Universidad Politécnica de Madrid
31 PUBLICATIONS **217** CITATIONS
SEE PROFILE

Xavier Ferre
Universidad Politécnica de Madrid
56 PUBLICATIONS **1,122** CITATIONS
SEE PROFILE

Elena Villalba Mora
Universidad Politécnica de Madrid
74 PUBLICATIONS **680** CITATIONS
SEE PROFILE

A scrum-based development process to support co-creation with elders in the eHealth domain

Jose Barambones[1 [0000−0003−3860−7257]], Cristian Moral[1 [0000−0002−8429−8822]], Xavier Ferre[1 [0000−0003−3474−9784]], and Elena Villalba-Mora[1,2 [0000−0001−6043−6322]]

[1] Centre for Biomedical Technology, Universidad Politécnica de Madrid, Spain
[2] Biomedical Research Networking Centre in Bioengineering Biomaterials and Nanomedicine (CIBER-BBN)
{j.barambones,cristian.moral,xavier.ferre,elena.villalba}@upm.es

Abstract. Since the publication of agile manifesto in 2001, agile methodologies has been gaining significant interest in both software industry and research community. Agile User-Centered Design (AUCD) assesses the challenge of integrating agile development with user experience and usability techniques. Although both methodologies have similarities, their scope and perspective are different and difficult to integrate. The eHealth domain implies additional challenges in terms of usability, due to the differences between healthcare professionals, and lack of knowledge of the day-to-day work carried out in different care tiers. Therefore, the challenge is twofold: to achieve an adequate symbiosis of work between teams, and design a solution adapted to the needs of diverse stakeholders with vast differences in their context of use. We designed a lightweight AUCD process adapted to such situation, and we present our experience in the design and implementation of such development process for the development of a system to monitor frailty in elder patients with support for both community and specialized care. As a result, our UCD process has achieved both iterative and incremental value generation, maintaining a good coordination between developers and UX designers, and resulting on a usable solution with regard to target users.

Keywords: Agile User-Centered Design · Experience report · eHealth · Elder users

1 Introduction

Scrum is an agile process framework for software development aimed to address complex adaptive problems, while productively and creatively delivering products with the highest possible value. Scrum teams are subject to a series of roles, rules, events and artifacts; and orchestrated through a set of well-defined relationships and interactions between them [16]. In an agile process, development is organized into a series of short and fixed-length iterations or sprints. The outcome of each sprint is a tested, integrated, and executable partial system,

including its own requirements analysis, design, implementation, and testing activities. The system grows incrementally with subsequent iterations, becoming an incremental development [13].

User-Centered Design (UCD) includes activities such as the specification of the context of use and the user requirements, producing design solutions, and evaluating them against such requirements [1]. UCD is inherently iterative to cope with the uncertainty of the human part in the human-computer interaction. Each iteration includes some kind of usability evaluation of the produced solution that determines if it is required to perform a new iteration, but repeating only the UCD activities that require some refinement.

Integration of UCD into agile approaches has traditionally found obstacles related to the lack of usability awareness and the different focus of Human-Computer Interaction (HCI) techniques compared to other development activities. The Agile User-Centered Design (AUCD) approach emerged to address these problems [4, 8, 9, 17]; however, although scrum is considered a lightweight process easy to adopt, the integration of UCD with agile methods remains challenging. The agile Manifesto[3] focuses directly on providing value as functioning software for the customer, whereas UCD aims for a proper understanding of users and their context to take design decisions according to their goals and expectations. Extensive user research activities, necessary for proper UCD, can be identified as big design up-front from an agile perspective, that defends having running software built from the very beginning. Both methodologies coincide in the need for and iterative approach and handle requirements and uncertainty in development from different approaches, either by integrating the client needs as the product owner or the objective user. However, there is a need to fit UCD activities into the overall agile process and to define how UCD findings drive redesign efforts in the software product.

Participatory design methods from UCD need to take into account technical and resource constraints. In our case we need to add the difficulties of applying UCD in the eHealth domain. User experience research with healthcare professionals show that they prioritize the medical error reduction to avoid unforeseen or harmful decisions to patients [2, 12]. Accordingly, special effort is required for understanding and designing for all stakeholders. Healthcare professionals are a scarce resource, and it is difficult to have them continuously as part of the development team, as agile approaches suggest. From the patient perspective, user satisfaction is critical to preserve his/her engagement and ensure proper adherence to treatment. Designing any software product for elders requires considering their possible limitations in technology background and physical and cognitive abilities. These limitations linked to elder users require the consideration of specific usability guidelines.

We present in this paper the instantiation of an AUCD software development process for the development of a telemedicine system to monitor elder patients with risk of frailty, merging a scrum-based approach with co-creation UCD ac-

[3] See http://agilemanifesto.org/

tivities. We extract measures from both scrum and usability metrics to discuss how the process fulfills the project objectives.

2 Related Work

With regard to AUCD adoption, Brhel et al. conducted a literature review on agile and UCD integration techniques, resulting on a foundation based on a set of principles, such as to merge effectively iterative and incremental development, and continuous stakeholder involvement, among others [4]. Fox and Ferreira defined different approaches to integrate agile methods with UCD and compare them in respective study cases with experienced software teams from industry [6, 5]. Garcia et al. identify through an ethnographic study the artifacts used to facilitate the communication between designers and developers in an AUCD approach [7].

Apropos of development and design for ageing, Ruzic et al. designed a set of guidelines to ensure usability of mobile eHealth devices by elder based on design principles from literature: universal design, design for aging, universal usability, and guidelines for handheld mobile interface design [15]. Lerouge et al. investigate how User Profiles and Personas techniques improve the design and development of consumer health technologies and devices for an aging population [14]. The study provides guidelines to tap into the conceptual models of elder population to reflecting their preferences and capabilities, but user motivation and adherence is considered superficially.

3 Context

Elder-associated conditions, e.g. frailty, and other health-related conditions are becoming a huge challenge to the sustainability of healthcare systems. Concretely, frailty condition is an intermediate state in the ageing trajectory, preceding the onset of disability.

POSITIVE project (maintaining and imPrOving the intrinSIc capaciTy Involving primary care and caregiVErs), funded by EIT Health, proposes a new organizational ecosystem to manage frailty, based on the basic model centered into the Geriatric Comprehensive Assessment (CGA) detailed in [18], but extending it to primary care professionals to allow for a closer contact with patients and their caregivers. This project implies the participation of health professionals at different levels (nurses, general practitioners, geriatricians, physiotherapists, occupational therapists, etc.), patients and their informal caregivers. The system allows professionals to carry out CGA in clinical settings and to remotely monitor patient's intrinsic capacity and prevent frailty through tailored intervention in community dwellings. Figure 1 shows the POSITIVE services offered through the developed platform. In a nutshell, POSITIVE system is composed by three main components: the professional app, the patient app, and the support ruled-based engines. Through the professional app healthcare professionals manage their activities such as patient monitorization, messaging and gathering

patient data during clinical visits. The patient app includes the functionality to assist and assess in a remote manner the patient intervention at dwelling. The rule-based engines are a sever-side service that receives patient data from clinical visits and home activities. Later, the engine analyzes the data to support care professional decision process for referring to specialized care professionals. Co-creation activities defined and refined the screens of the Patients Dashboard (figure 4), New Visit, and Home activities (figure 5), and served for defining the rules of the side support components (alerts and referral engines).

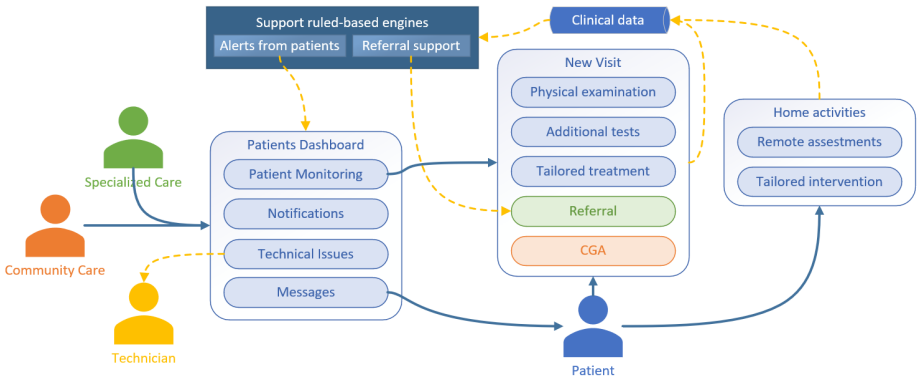

Fig. 1. POSITIVE platform schema.

4 AUCD process proposal

The project team is composed by two sections: Development (Dev team) and User eXperience (UX team). The UX team deals with user research and is responsible for the high-level design of the solution, through co-creation activities, while the Dev team is responsible for the implementation and software testing activities. A set of healthcare professionals participate in co-creation activities as a relaxed case of product owners. These participating stakeholders are exempt of backlog/project management, though the UX team acts as spokesperson for the users in the generation of the backlog, collaborating with the Dev team in such purpose.

Figure 2 shows the deployed AUCD process for the POSITIVE project. Subteams possess their own work pipeline, where each team processes the data from the other team at the previous iteration. Accordingly, the Dev team performs a scrum sprint given the backlog generated, whilst the UX team works in the design of the following iteration in co-creation activities. Prototype validation, design, and refinement are performed over subsequent releases, thus both iterative pipelines converge onto an incremental development. The following subsections describe the iteration process and its activities.

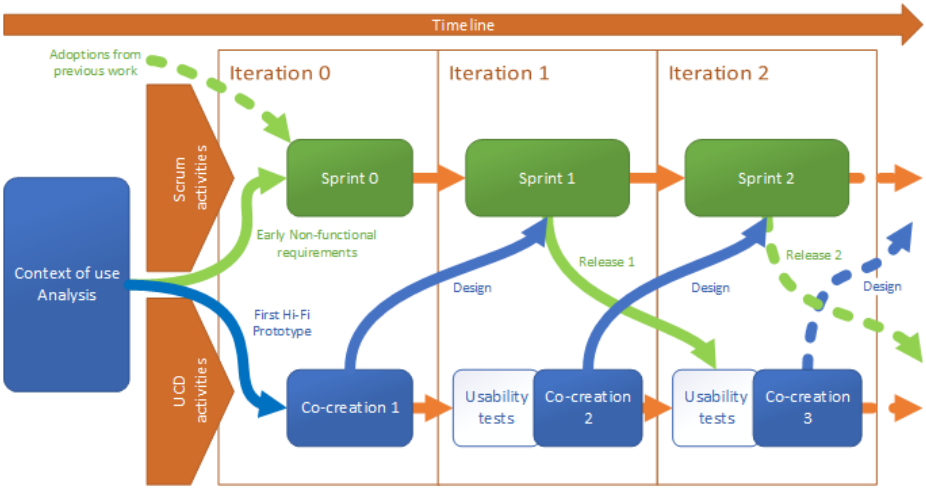

Fig. 2. Integration of UCD and base scrum sprints in our applied process.

4.1 Sprint iteration

Figure 3 describes the activity flow over a single iteration from figure 2. As mentioned above, the sprint receives the design requirements and works over the last deployed release. In other words, the backlog from current iteration is generated and updated from design results obtained on the previous UCD iteration. As output, a new release is deployed and a new set of design requirements from co-creation and usability tests are delivered. In this way, development activities can be parallelized with the next design iteration. Indeed, this flow enables both teams to be coordinated through different meetings, appointments and common activities in such a way that ongoing decisions are made with up to date information. Team dailies are held with the entire team allowing for the status of both teams to be effectively shared and coordinated.

Kick-off: Previous work consisted on extensive user research activities, including observation at the Geriatrics Unit of the University Hospital of Getafe and semi-structured interviews with key stakeholders [18], followed by several iterations of prototypes for the UI of the system to support the CGA carried out by geriatricians. The overall POSITIVE ecosystem, including primary care professionals, was designed at time of project proposal, so when the actual development started there was a clear product concept defined, even if the prototypes were outdated and needed to be considered from scratch due to the new organizational model implied in the project.

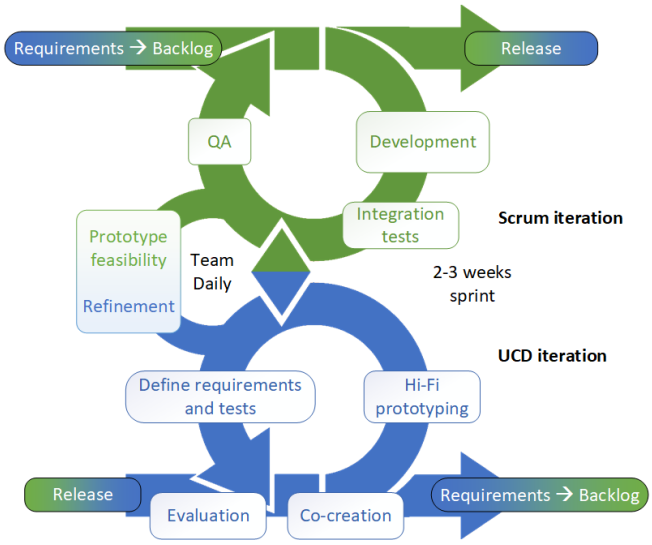

Fig. 3. AUCD iteration flow with activities per pipeline.

4.2 UX activities

Co-creation: Co-creation activities can effectively involve different stakeholders on design decisions, revealing hidden requirements and restrictions which may be difficult to identify otherwise. Based on participatory design principles, they are aimed to understand properly the potential users of a product, to identify the real context of use, and to ensure that the proposed design actually fits both users and context [10].

Co-creation requires users to be actively involved in the design process. The aim of the scheduled co-creation sessions was to define the context of use through activities where stakeholders are actively implied. In our case, we have used two methods: focus groups and pluralistic walkthroughs. A Focus Group is a qualitative research technique that is specified as a meeting of potential users where participants give their opinion about one or more topics [11]. The most interesting output of this technique is the debate created between the participants, as this forces them to defend, argue and justify their ideas, and then to externalize their real mental model. Having a total of 15 primary professionals and 5 geriatricians participating in the co-creation activities allowed us to uncover different viewpoints and lack of knowledge about how other care tiers work. A single product owner would have not been able to provide enough information for such a complex care ecosystem. A pluralistic Walkthrough is a usability inspection method where stakeholders, including users of any role, designers and developers revise the design. This helps specifying in detail the tasks that must be developed from different role-perspectives and brought together [3].

Hi-Fi prototyping: The early design output is generated from co-creation decisions. The Hi-Fi prototype is extended with that output, in such a way that design becomes incremental along the iterations. Subsequent usability testing the generated prototypes allows for the required design refinement. Figure 4 and 5 show some prototypes used later in UX activities.

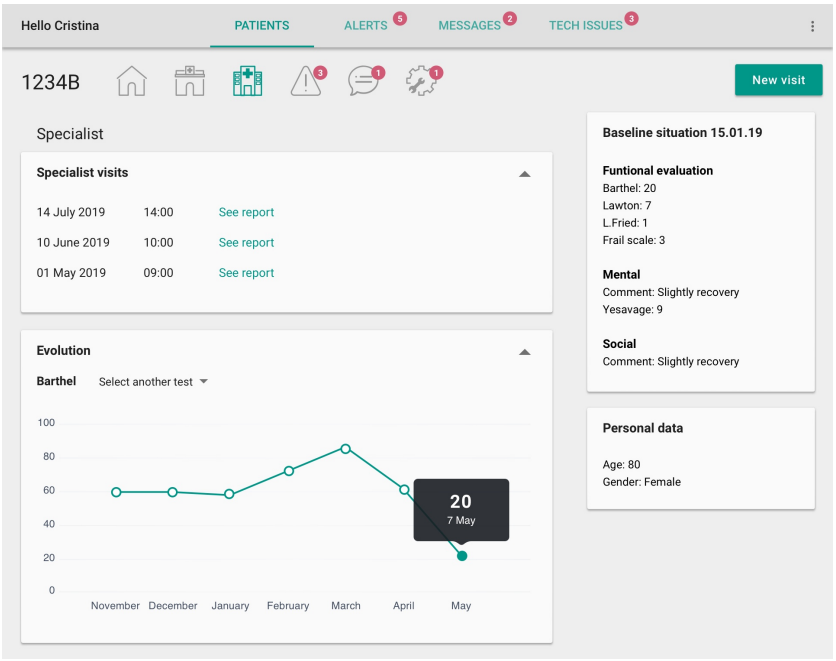

Fig. 4. Hi-Fi prototype for the professional view.

Requirements and tests: From co-creation activities, requirements are collected according to the professional knowledge and their mental model. This data is formatted into documentation for the dev team in different assets. The Hi-Fi prototype validated by stakeholders through co-creation activities embodies the system requirements. Such source of requirements include the set of acceptance tests for the subsequent evaluation. Requirements and tests are translated to simple input/output tasks or user stories with pre/post conditions and attached test cases. Such tasks are classified by story points from scrum estimation. In our case, the difficulty emerges given a backlog that is increased with new features or epics in further iterations. This implies that the estimation and priority can only be done with the information of the current iteration plus the remaining undone tasks. To overcome this, co-creation activities were scoped in initiatives

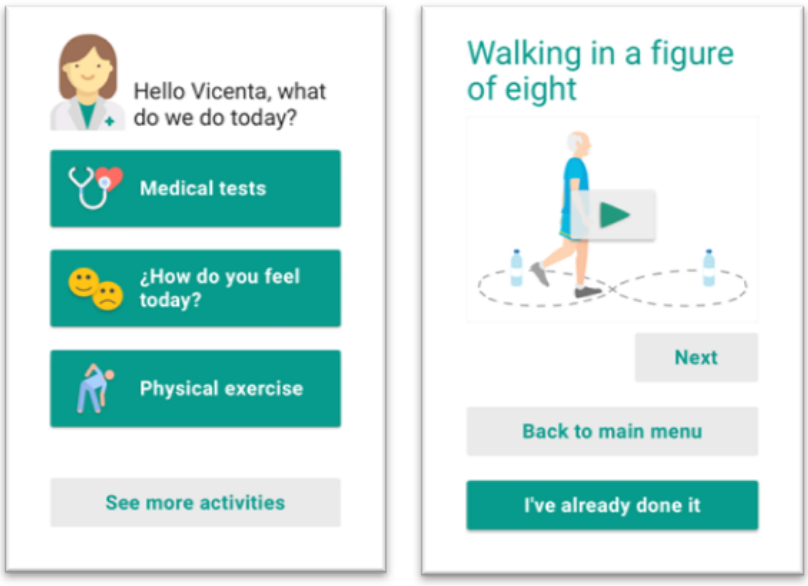

Fig. 5. Hi-Fi prototype for the patient view.

or big epics, in such a way that iterations are differentiated, dependencies are minimized, and to ensure the critical tasks from each epic are prioritized.

Evaluation: Usability tests were performed with community and specialized care professionals, and with elders in their homes. During testing, participants were asked to complete typical tasks while observers watched, listened and took field notes with the aim of identifying usability problems, collecting qualitative/quantitative data and determining the user satisfaction. Quantitative results were collected using System Usability Scale (SUS) questionnaires, while qualitative findings were gathered through deep contextual interviews. The Think Aloud protocol was used for the usability tests to collect qualitative data allowing to explain when and why errors were made, and to identify the reasons for the user problems.

4.3 Dev activities

Development environment: The Dev team follows the Dev-QA-Prod pipeline. The Dev environment is used to code new features, to perform functional tests, and to fix bugs. The process is iterated until the code is ready for the next stage of testing. The quality assessment environment (QA) is used for testing by the UX team and domain experts carry out heuristic usability evaluation, with redesign decisions reported back to the Dev team if necessary. The end-user release is deployed in the production environment once the QA environment has been

thoroughly tested and and its stability and performance has been checked. The pipeline is managed by a control version software with a continuous integration framework that allows to automatically deploy and test the releases in their respective environment.

Integration and Quality Assessment: Integration assets have been grouped in different test sets according to their purpose. Integration tests are non-functional tests related to networking and infrastructure assets, and incremental tests ensuring the correct integration of the new release onto the current deployment. QA consists on passing a set of test cases designed by the Dev team that ensure a proper system response according to the elicited requirements and acceptance tests.

4.4 Team Daily

Dailies are the most important activity of our AUCD process. Both teams participate in team dailies to ensure coordination between them. On the one side, the UX team provides information about the subsequent design decisions, shows the current prototype and provides feedback about the integration in terms of interaction with regard to the current release. On the other side, the Dev team provides the current status of the development, including dev planning, functionality priority and tests. From the output given by both teams, daily agreements are achieved. At this point, team objectives are well-defined: the UX team aims to control and support refinement tasks for developers to fix possible deviations or slips during development, while the Dev team evaluates and agrees design decisions based on their technical viability. Thus, the whole team information is up to date, and priorities, deviations and issues are properly managed.

5 Application results

The proposed process was applied during 6 iterations until the first release was completed. The team was composed by 4 software engineers and 1 dev lead senior, 2 UX researchers, and 1 scrum master. Figure 6 summarizes both usability and scrum results: bars represent the different SUS values obtained at the end of each iteration. It is important to note that SUS questionnaires were conducted with the involved stakeholders on the sprint, either professionals, patients, or both. Lines represent the story points progression, where the yellow line determines the estimated story points at the beginning of the iteration, and the green one the completed at the end of it.

The UX team conducted during this period a set of five consecutive walkthrough sessions to progress iteratively and incrementally co-design with the potential users. Those workshops ensure that all the required functionalities have been considered and that they are implemented based in the users' needs and preferences. Usability tests were always conducted by one UX researcher, and at least a second UX researcher observed, took notes and collected the data

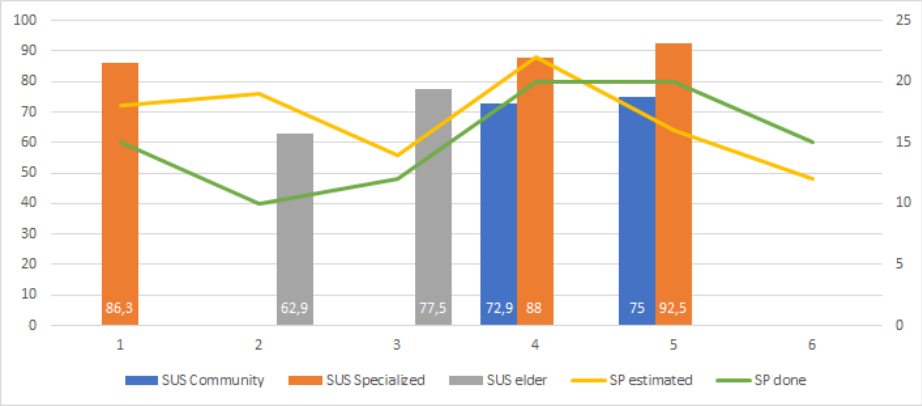

Fig. 6. Quantitative results by iteration. On the left axis, SUS values are broken down by user profile according to the different focus groups during co-creation activities and evaluation. On the left axis, story points estimated vs. done in each sprint.

during the test. Usability testing results were used as the main criterion to iterate. Regarding the development pipeline, submitted releases are related to the different components briefly described in figure 1. The first iteration was focused on the first release of the CGA for specialized care professionals (geriatricians). Second and third iterations were focused on patients' tasks, monitoring, and intervention at dwelling. Iteration 4 was focused on tasks were primary and specialized care professionals converge (referral, communication, alerts, and sharing data, among others). In this iteration the Dev team participated in the walkthrough session due to the complexity of several tasks to be designed. Thus, issues, solutions and decisions related with viability, alternatives, and technical requirements were held from the beginning. Iteration 5 consisted on the incremental inclusion of the remaining stakeholders (technical, staff, caregivers, other professionals, etc.). The last iteration performed tackled the different pending tasks carried over from previous iterations, refinement of certain user stories, and low priority tasks.

In iteration 2, the first one with elder patients, users expressed they would like to interact with the system frequently, but at the same time, they thought there was too much inconsistency in the system, resulting on an overall SUS value of 62.92, which is below the average (68). The subsequent iterations were mainly focused on solving and mitigating the detected issues on priority tasks. Finally, patients stated that they would like to use the system regularly, in case they would need to monitor their health status, but still expressed that there were some problems about lack of well-described instructions for some complex tasks. Regarding healthcare users, they perceived that the system is easy to use, well-adapted to their needs, and that they would not require help or further assistance by the UX facilitator to perform the tasks. On the other hand, we detect on later iterations the different work constraints between profiles. For example, primary

care professionals have very short medical visits to attend their patients, so they are more reluctant to add a new system to their work routine. Due to these results, task refinements were critical in sprints 3 and 5, so the expected new story points to complete were significantly reduced. Later iterations reflect how once the main user stories were successfully finished and refined, the Dev team could focus on low priority and pending stories from the backlog. Indeed, this situation allowed to turnaround the trend where more stories were performed than estimated.

6 Discussion

Overall, the design and adoption of this AUCD process was successful in different perspectives. From an organizational point of view, to allocate team members to UX or Dev pipelines allowed to focus the best effort according to their skills. Activities where the UX and Dev team worked together, such as daily meetings and a pluralistic walkthroughs, allowed both teams to stay up to date and react to problems from different perspectives. Regarding the artifacts delivered by the UX team, such as prototypes, task descriptions and acceptance tests, they were easily adopted by the Dev team due to their similarity with common agile artifacts. From a product/value-perspective, incremental design and development has been usually accompanied by good acceptance by target users; where the different stakeholders found the app easy to use and well-adapted to their needs.

There were relevant deviations in the estimation of effort for different parts of the system, due the complexity of dealing with multiple stakeholders and the specificities of the health domain. In particular, some tasks were downplayed in the system after identifying that the initial overall approach for such section was not possible, and effort estimations had to be modified accordingly. In addition, from the UCD part, it is worth mentioning that, although patient acceptance was achieved, several difficulties during UX activities were found. Additional iterations were required to better accommodate the designed user interfaces to the elders and their caregivers, due to the specific interaction limitations of this user base.

In a project involving different care tiers, like primary and specialized care, it is more difficult to identify a single customer. Lack of availability of healthcare professionals for development activities may cause that eHealth projects cannot carry out a traditional scrum inception. In our case, this led to some prioritisation mismatches, that both teams had to deal with. Our experience is an example of the inherent difficulties of integration of UCD and agile approaches in the eHealth domain.

7 Conclusions and future work

We have designed and deployed an AUCD process based on co-creation and scrum activities for a frailty monitoring eHealth platform. The process was aimed to apply a scrum-based methodology in a context with strong requirements on

usability that includes quite differentiated contexts of use. Such contexts include different roles/profiles: community and specialized care professionals, elder patients and other stakeholders like caregivers, occupational therapists and nurses, among others. The process consists of two interlaced pipelines focused on agile and UCD activities and their specialized teams. Requirements and prototypes from co-creation are used as input for Dev team as user stories and tests, whilst releases are submitted to UX team and users for validation and further design. The Dev-QA-Prod pipeline was used to properly parallelize development and tests with design, the validation and the staging. As a result, both iterative processes properly converge to contribute to incremental development and create value. Usability evaluation results state that users found the platform easy-to-use and learn, and adapted to their needs.

Providing tools and activities to improve the big picture of the backlog and help users to compare the value between different epics are proposals for future adoption. In our further steps, the platform will be deployed in a clinical pilot involving 75 elders and 25 professionals from Spain, Poland and Sweden.

References

1. 9241-210:2010, I.: Ergonomics of human-system interaction — part 210: Human-centred design for interactive systems (2010)
2. Ash, J., Berg, M., Coiera, E.: Some unintended consequences of information technology in health care: The nature of patient care information system-related errors. Journal of the American Medical Informatics Association : JAMIA **11**, 104–12 (03 2004)
3. Bias, R.G.: The Pluralistic Usability Walkthrough: Coordinated Empathies, p. 63–76. John Wiley & Sons, Inc., USA (1994)
4. Brhel, M., Meth, H., Maedche, A., Werder, K.: Exploring principles of user-centered agile software development: A literature review. Information and Software Technology **61**, 163 – 181 (2015)
5. Ferreira, J., Sharp, H., Robinson, H.: Values and assumptions shaping agile development and user experience design in practice. In: Sillitti, A., Martin, A., Wang, X., Whitworth, E. (eds.) Agile Processes in Software Engineering and Extreme Programming. pp. 178–183. Springer Berlin Heidelberg, Berlin, Heidelberg (2010)
6. Fox, D., Sillito, J., Maurer, F.: Agile methods and user-centered design: How these two methodologies are being successfully integrated in industry. In: Agile 2008 Conference. pp. 63–72 (2008)
7. Garcia, A., da Silva, T.S., Silveira, M.S.: Artifact-facilitated communication in agile user-centered design. In: Kruchten, P., Fraser, S., Coallier, F. (eds.) Agile Processes in Software Engineering and Extreme Programming. pp. 102–118. Springer International Publishing, Cham (2019)
8. Hussain, Z., Slany, W., Holzinger, A.: Current state of agile user-centered design: A survey. Lecture Notes in Computer Science **5889 LNCS**, 416–427 (2009)
9. Hussain, Z., Slany, W., Holzinger, A.: Investigating agile user-centered design in practice: A grounded theory perspective. In: Holzinger, A., Miesenberger, K. (eds.) HCI and Usability for e-Inclusion. pp. 279–289. Springer Berlin Heidelberg, Berlin, Heidelberg (2009)

10. Jansen, S., Pieters, M.: The 7 Principles of Complete Co-Creation. Laurence King Publishing (2018)
11. Krueger, R.: Focus Groups: A Practical Guide for Applied Research. SAGE Publications (2014)
12. Kushniruk, A.W., Triola, M.M., Borycki, E.M., Stein, B., Kannry, J.L.: Technology induced error and usability: The relationship between usability problems and prescription errors when using a handheld application. International Journal of Medical Informatics **74** (04/2005 2005)
13. Larman, C.: Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development (3rd Edition). Prentice Hall PTR, USA (2004)
14. Lerouge, C., Ma, J., Sneha, S., Tolle, K.: User profiles and personas in the design and development of consumer health technologies. International journal of medical informatics **82** (04 2011)
15. Ruzic, L., Lee, S.T., Liu, Y.E., Sanford, J.A.: Development of Universal Design Mobile Interface Guidelines (UDMIG) for Aging Population. In: Antona, M., Stephanidis, C. (eds.) Universal Access in Human-Computer Interaction. Methods, Techniques, and Best Practices. pp. 98–108. Lecture Notes in Computer Science, Springer International Publishing, Cham (2016)
16. Schwaber, K., Sutherland, J.: The scrum guide (2017), www.scrumguides.org
17. Silva da Silva, T., Martin, A., Maurer, F., Silveira, M.: User-centered design and agile methods: A systematic review. In: Proceedings of the 2011 Agile Conference. p. 77–86. AGILE '11, IEEE Computer Society, USA (2011)
18. Sánchez Sánchez, A., Villalba Mora, E., Peinado, I., Rodríguez-Mañas, L.: Integrated care program for older adults: Analysis and improvement. The journal of nutrition, health & aging **21** (12 2017)