A Framework for Agile and UX Integration in Healthcare Software Development: A Kanban Approach

Emanuel P. Vicente[1] [a], Wilamis K. N. da Silva[1] [b], Geraldo T. G. Neto[2] [c]
and Gustavo H. S. Alexandre[1] [d]

[1]*CESAR, Recife Center for Advanced Studies and Systems, Apolo Street, Recife, Brazil*
[2]*IFMS, Federal Institute of Mato Grosso do Sul, Corumbá, Brazil*
{*epv, wkns, ghsa*}*@cesar.school, geraldo.galindo@ifms.edu.br*

Keywords: Usability, Usability Method, UCD, Usage-Centered, Medical-Hospital System, Doctor, Health, Medicine, Patient Safety.

Abstract: The expansion of medical applications increasingly requires quality in their interfaces to mitigate usability problems and improve the patient experience. The development of healthcare applications presents challenges in the field of usability due to the risk of impact on patient safety. This article addressed these issues by integrating User-Centered Design and Agile Software Development (ASD), creating several kanban boards to organize the flow of tasks between designers and developers. This study evaluated the integration of User-Centered Design (UCD) practices the use of Kanban as an ASD method during the development of an electronic appointment scheduling subsystem in a Hospital Information System (SIS). Semi-structured interviews were carried out with 10 project members on fourteen questions about the challenges and opportunities of integrating UCD practices with the Kanban method in the healthcare context. Through qualitative analysis, we concluded that the integration of these approaches led to the expansion of software engineering knowledge in the area of usability, UX and agile development, in addition, it helped to organize the flow of activities, improve the relationship between interaction and development designers teams. developers and reduce the number of usability problems in healthcare software products.

1 INTRODUCTION

Currently, the software industry has invested in increasingly innovative solutions in the healthcare area and has driven the digital transformation of this area, with the development of applications, platforms and healthcare information systems that have been transforming the form of interaction between patients and Health professionals.

The use of digital tools that can assist healthcare providers like Clinical Decision Support Systems (CDSS) are increasingly present in the daily lives of healthcare professionals, in hospitals and clinics, helping with diagnosis and decision-making and improve various aspects of healthcare delivery, such as patient safety, clinical management, diagnostic support, cost management, and administrative ef-

ciency (Abell et al., 2023). CDSS can take diferent forms, such as guideline-based algorithms for chronic disease risk and screening, personalized medication dosing, and alerts for potential or historical adverse events.

These systems are widely used in various healthcare environments and play an important role in providing healthcare services that ensure safety, efficiency and effectiveness (Woldemariam and Jimma, 2023). However, research has shown that several healthcare systems have faced some usability challenges leading to clinician frustration and workflow inefficiencies (Kalli, 2022).

Also, previous research work on usability of Hospital Information System (HIS) and CDSS suggests that poor usability contributes to the decreased cognitive performance of clinicians, low efficiency, workflow interruption or disorientation, raised medical error risks and higher numbers of adverse events (Ghorayeb et al., 2023).

In this context, Agile Software Development (ASD) can be an alternative to mitigating this chal-

[a] https://orcid.org/0009-0008-9859-8819
[b] https://orcid.org/0000-0002-8530-5916
[c] https://orcid.org/0000-0001-7244-8822
[d] https://orcid.org/0000-0002-8347-6383

lenge. Annually, the *State of Agile survey* [1] conducts a survey with professionals in the agile context with the aim of understanding the benefits and challenges of adopting agile. In 2023, it was observed that 59% of professionals were either very or somewhat satisfied with Agile in their organizations to support of improvements in their development process and also to achieve a digital transformation throughout the entire development cycle of their products.

Despite this, it is observed that agile methods and usability practices are not part of the same process, despite the ISO/IEC-9126(2003) standard indicating that usability is considered a technical quality attribute for software design, even if usability is considered a non-functional requirement in Software Engineering (SE).

Usability can be considered as one of the main quality characteristics of a system. Usability can be defined by ease of use and the extent to which a product is used efficiently, effectively and satisfactorily by specific users in carrying out objectives(Iso, 1998). A poor usability score generates a drop in user efficiency and widespread dissatisfaction with the quality of an HIS (Farrahi et al., 2019).

In this context, it is necessary to adopt practices to guarantee an agile software development process, but also including a humanized look with User-Centered Design (UCD), making it necessary to direct attention to end users during all phases of a software project. This look is described by Lowdermilk(LOWDERMILK, 2019) such as UCD where usability processes are focused on the end user, resulting in a better quality application from the perspective of those who use the system.

For HIS with usability problems, the impact of usability failures increases the chance of medical error and can lead to a disaster, such as prescribing the wrong medications or inappropriate dosages (Koppel et al., 2005) and (Jaspers, 2009). On the other hand, systems with high usability help users to carry out their tasks safely, quickly, easily and with minimal mental effort(Rezaei-Hachesu et al., 2016). Therefore, it is highly recommended that during the development of new systems, usability is regularly evaluated during all phases of construction, in order to identify and resolve unforeseen problems(Khajouei and Jaspers, 2010).

This article proposes the application of integrated UCD practices in an agile context using Kanban during the development of an HIS subsystem in a large military hospital.

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[1]https://stateofagile.com/

2 RELATED WORK

One of the first works to carry out this discussion was carried out by Constantine and Lockwood (Constantine and Lockwood, 2002) proposed a simplified version of User-Centered Design (UCD) aimed at integrating 'lightweight' agile methods. Their study highlighted that UCD can be effectively combined with agile processes through user involvement in initial phases, facilitating better planning and usability evaluation

It was found that users themselves could contribute to writing "user stories" and help in modeling and prioritizing design activities. This characteristic of approaching the user in the initial phases of the requirements elicitation process is one of the usability principles and allows the contexts of use to be identified, as well as providing better support for the planning and definition of usability evaluation parameters.

Sy (2007) presents a working model that seeks to integrate UCD activities in a generic way into the ASD(Sy, 2007) process. Based on the basic process of incremental development, and conceptualizing the activity of the design and development teams to occur separately, the author proposes the use of alternating activities originating in a cycle prior to the beginning of the development cycles, only for initial requirements elicitation and scope planning in the first development cycle. In this way, requirements gathering and planning activities would always be carried out one cycle in advance of the interface development cycle, remaining for a round after quality verification and testing activities.

Despite the evolution of the model proposed by Sy, it does not present a solution for managing changes during interactions, caused by less communication between teams throughout the cycles and the fact that both teams are working on different sets of features to be implemented. To solve this problem Silva(Da Silva et al., 2012) proposes some changes to the model, allowing, throughout the cycles, communication between teams, in addition to increasing the scope of team activities to cover not only the immediately subsequent cycles, but also the previous ones. It is also noteworthy that both Sy and Silva's approaches do not present a closure cycle for the project in terms of quality verification for the final product development cycle.

Next, some studies that proposed integration between ASD and UCD will be presented. This topic will present three studies on the integration of usability processes with the main agile methods such as: XP, Scrum and Kanban, with the main attention focused on this last method, which is the focus of the study our thesis.

2.1 Integration Between UX and XP

Silva(Silva et al., 2009), presented XPu as a method of integration between XP and the Praxis-u usability process. Method used in the Department of Computer Science at the Federal University of Minas Gerais - UFMG and integrated into Praxis (de Pádua Paula Filho, 2009).

In the XPu method, technical activities begin with User Analysis, which is carried out using Personas (Cooper et al., 2014). Developed by Alan Cooper (Cooper et al., 2014), this technique aims to characterize groups of end users through direct observation of users in their usual work environments. Through the use of Personas, it is possible to produce simple and typical prototypes for these end users.

In addition to the production of prototypes, Task Analysis takes place in parallel through the production of Scripts (Rosson and Carroll, 2002). Scripts are used as an HCI technique that textually describes the details of the execution of a task by a user profile. The Scripts are, therefore, the representation of usage situations, being used to understand users and their respective needs.

The Usability Context Analysis completes its activities at the end of the User Analysis and Task Analysis, which will result in the representation of Usability Stories. Usability Stories and User Stories, already used by the XP method, cannot be confused, as there is an important difference between them. Since User Stories are written by the client in the XP method, Usability Stories are described by the Interaction Designer, which is a role suggested by the second edition of the XP method (BECK,) and incorporated and implemented by XPu. The Interaction Designer, who is assisted by the client, is responsible for all proposed usability activities.

2.2 Integration Between UX and SCRUM

Singh (Singh, 2008) introduced U-SCRUM, an adaptation of the Scrum methodology that integrates usability principles by incorporating a Usability Product Owner role. This role centralizes usability tasks, addressing the lack of predefined usability processes in traditional agile methods. U-SCRUM has shown improvements in usability outcomes by ensuring early and ongoing user involvement.

The work applied this adapted method in business oriented projects to obtain validation of the results. The approach used by U-SCRUM produced considerable improvements in the level of usability of the developed artifacts, according to the author, who

pointed out benefits, including for end users and other stakeholders.

2.3 Integration Between UX and KANBAN

While significant research explores the integration of UCD practices with XP and Scrum (e.g., (Silva et al., 2009); (Singh, 2008)), studies on Kanban remain limited. Despite its growing adoption in software projects (Komus and Kuberg, 2017), academic exploration of Kanban's compatibility with UCD is still emerging.

One of the first studies that sought to improve the integration of Kanban with UCD was carried out by Schön, 2016 (Schön et al., 2016). In that study, multiple kanban boards were implemented to control the flow of tasks in the design and development teams, as show in Figure 1.

This study investigated the integration of Human-Centered Design (HCD) and Kanban with the aim of gaining market experiences in a real-world context. Their case study showed that requirements flow into the development process in a structured way, using a unique kanban board for design and another for development. This approach increased transparency regarding recurring requirements and contributed to the production of knowledge about the integration between agility and UCD providing practical insights into human-centered agile development. The work demonstrated that the integration of these approaches produced deliveries with good UX, in addition to making the development process more human-centered. Furthermore, he concluded that cross-functional collaboration between design and development teams accelerates product development.

Despite the maturity regarding the integration between UCD and Agile, after just over two decades of discussions, it still has challenges mainly in two main issues: company negligence of UX and UCD, and decentralization of organizational structure (Welin, 2024)

3 RESEARCH OBJECTIVES AND STUDY DESIGN

3.1 Objectives

The aim of our study is to gain empirical insights in the integration of UCD and Kanban and to prove whether the execution of this action research cycle managed to adapt an integration process between

ASD and UX using Kanban and usability inspections to overcome the main challenges of integrating these approaches, as mapped by Salah, (SALAH, 2014) as:

- C1 - Lack of time to plan advance design activities;

- C2 - Difficulty in fragmenting activities;

- C3 - Difficulty in prioritizing Design activities;

- C4 - Difficulty integrating work between developers and Designers;

- C5 - Develop usability tests;

- C6 - Design workload; It is

- C7 - Lack of documentation.

3.2 Research Context and Setting

We apply the approach proposed by Schön,(Eva-Maria Schön and Thomaschewski, 2016)) to create multiples kanban boards to organize the flow of tasks between designers and developers, as detailed in Figure 1. This paper was carried out as a case study in military hospital investigation is the integration of UCD over Kanban in a real world context.

This study was conducted as part of a broader effort to develop a web app, known as the SANDRA, based on HIS. The development occurred at an militar hospital with in Brazil.

3.3 Research Questions

We defined the following research questions which can be mapped to C1-C7 as followed:

- RQ1 - Does integration between kanban and UCD help mitigate the lack of time to plan design activities in advance?

- RQ2 - Does integration between kanban and UCD improve fragmentation and prioritization of design activities?

- RQ4- Does the integration between kanban and UCD improve the relationship between developers and Designers?

- RQ5 - How multiple kanban boards improve planning and execution of usability tests?

- RQ6 - Integration between kanban and ASD helped reduce design workload?

- RQ7 - Integration between kanban and ASD helped to mitigate a Lack of documentation?

3.4 Ethical Considerations

All data were collected in Portugues and pseudonymized (deidentified) with participants' informed consent. Confidential audio recordings of semistructured interviews were used for data analysis, and participants were identified only by alpha-numeric codes.

3.5 Data Collection and Analysis

In order to gain qualitative insights, we conducted semi-structured interviews with 10 project members. The interviews were carried out 1 month after the completion of the project. An interview consisted of fourteen questions and typically took 20 to 30 minutes. The original interview questions (Portuguese language) can be found in Multimedia Appendix A.

4 RESULTS AND DISCUSSION

RQ1 - Does integration between kanban and UCD help mitigate the lack of time to plan design activities in advance?

Regarding the lack of time to plan the advance of design activities the integration process sought to encourage design planning activities during the implementation of the scheduling system development action plan, as the condition of the activities In frame design and development, we strive to ensure responsiveness to changes in usability and functional requirements.

> *"design activities were placed ahead of coding activities. This improved the process as a whole, as user stories were now written by the design team and no longer by the project manager or the developer themselves. The prototypes and user stories arrived with greater detail and context of use, which helped to mitigate gaps in understanding when implementing the requirements and brought development closer to the need for use. "* (E3, Developer).

RQ2 - Does integration between kanban and UCD improve fragmentation and prioritization of design activities?

The difficulty of fragmenting and prioritizing design activities was overcome after adopting the adapted integration model, as it allowed the partitioning of design activities into groups of smaller activities, and
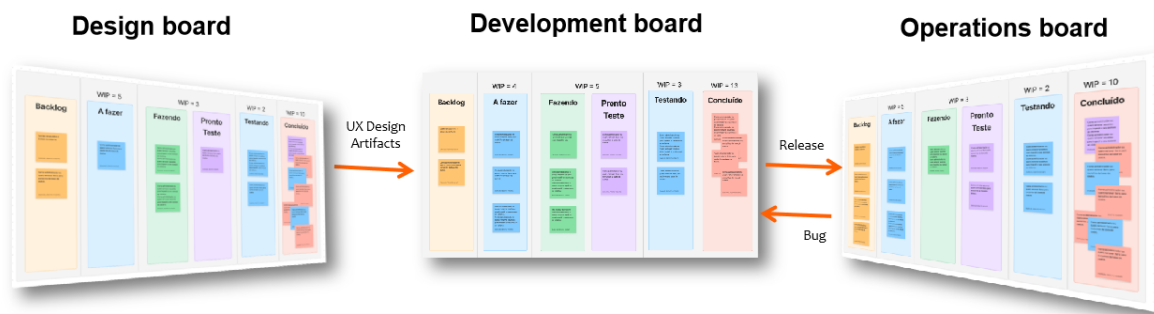
Figure 1: Multiple activity flows through the adapted process of multiple kanban boards proposed by Schön (Schön et al., 2016).

also allowed adequate planning of Requirements Engineering (RE) activities, both usability and functional requirements of the electronic scheduling system (E3 and E4). **Tactical UX Activities** carried out the work of orchestrating UX operational activities, coordinating user investigations, their tasks and the environment of this context of use.

Another benefit reported by an interviewee (E8) was that the kanban board contributed to better prioritization of activities, as with the adoption of different kanban boards, each board had its own backlog and followed their respective execution flows and had their own people responsible.

Does integration between kanban and UCD improve the relationship between developers and Designers?
Integrating developers and designers remains a key challenge in multidisciplinary projects. However, interviewees (E3, E7) reported that adopting multiple Kanban boards significantly improved collaboration and accelerated release cycles. For instance, E5 highlighted that this approach clarified requirements, fostering effective teamwork between design and development teams.

One participant (E5) reported that one of the benefits of cross-functional collaboration, provided by the adoption of multiple kanban board integrated to usability approaches, was that developers had a better idea of the requirements and there was effective collaboration between the design and development teams. The same interviewee also reported that the "good morning" meetings managed to be quite collaborative and managed to bring to light all the information necessary for the progress of the day's activities, however, another interviewee (E6) reported as a negative factor that the "good morning" meetings would eventually last more than 1 hour.

The meetings at the beginning of the working day helped developers get the point of view of UX specialists and vice versa for certain doubts in their respective activity boards (E4, E9). The project manager (E2) also reported that there was greater debate between developers and designers about complex problems that the project faced, as well as a greater perception about the speed of the project (E2).

How multiple kanban boards improve planning and execution of usability tests? For some interviewees (E4, E6, E8 and E9) the process helped develop usability tests efficiently, it also helped in defining tests and in the activities of defining requirements and usability metrics/UX, in addition to improving flow control of existing test cards on the board.

For one interviewee (E9), it was clear that controlling design activities in an exclusive framework helped to organize the flow of developers' tasks, as now so many usability activities were concentrated in another team, as were the activities of the development framework. became leaner and more organized.

Integration between kanban and ASD helped reduce design workload? The adapted process made it possible to balance the workload of Designers (E6 and E4), as it managed to optimize the flow of tasks on the Design Kanban board and dedicate the team's efforts to these activities. According to Salah, not all organizations have the financial resources to allocate design experts(SALAH, 2014). Using kanban in multiple boards helped (E4) to optimize this work, as this function ended up being carried out by a member of the development team and everything was controlled in the same square. According to the same interviewee (E4), a permanent team of designers has now been created and the workload has been balanced appropriately.

Integration between kanban and ASD helped to mitigate a Lack of documentation? For Salah (SALAH, 2014) the lack of documentation is one of
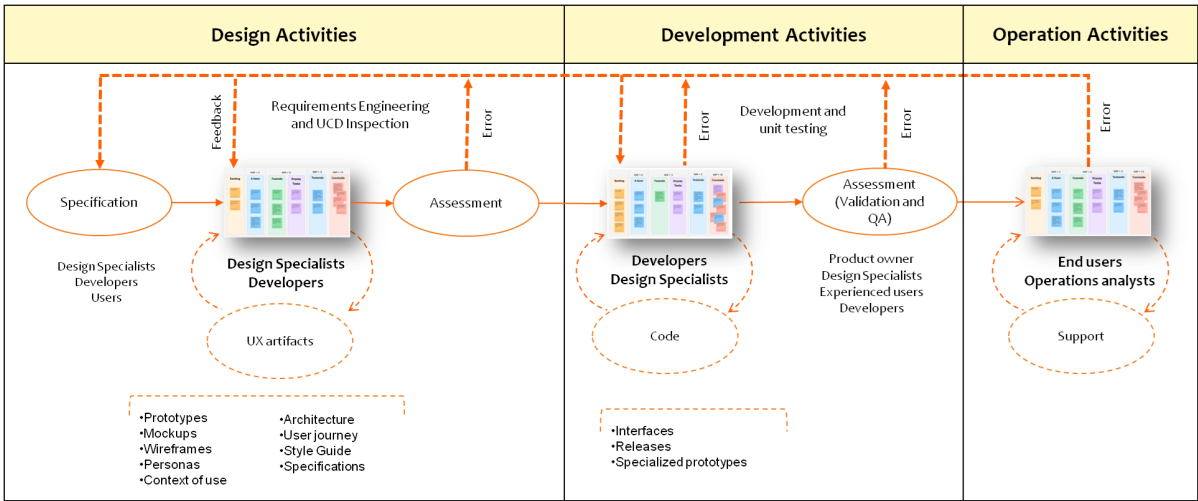
Figure 2: Activity flow of the Kanban and UX integration process.

the major problems affecting the integration between agile approaches and UCD, however, for the interviewee from the development and Design teams(E3-E7) The process adopted has documentation on the guidelines for executing tasks on Kanban boards, as well as guidelines for carrying out tactical and operational activities.

> "We plan to insert usability inspection activities in almost all prototypes developed by the design team, and iterative carry out refinements that help us document as many aspects of contexts of use, personas, tasks and user stories of our interfaces as possible." (E9, Interaction Designer).

An interviewee (E9) reported on the improvement in the quality of User Stories that arrived in the development kanban board's backlog, coming from the design board and which underwent successive refinements after the design team used the inspection form templates, **Appendix B**.

Finally, one of the members of the operations team (E9) observed that the versions released for operation are generating fewer errors.

> "Despite the adoption of more activities within the project with the new framework system exclusive to Design, I found that the inclusion of these design activities brought benefits to the release time in general. This is because, basically, the time lost with the construction of UX artifacts was gained back with the specification of requirements enriched with details, and this was reflected in more mature interfaces with fewer errors and bugs. The development team had less rework to correct nonconformities in the product and code refactoring. We noticed a higher compliance rate in inspections and unit tests. The team also gained more effective time to move cards to implement effectively new stories. Even the production environment has generated fewer demands for error correction." (E6, Developer).

It was possible to conclude that the multi-kanban board aprouch guaranteed the agility of the development of the scheduling module. It was also possible to validate that the process brought greater integration between the DAS and UX approaches. Usability inspections ensured the delivery of UX artifacts with greater details about the personas, their tasks, the context of use of the interfaces and in which environment this use would occur. All of this contributed to requirements engineering being improved to deliver better stories to be implemented.

The teams separated the demands of the Design and Development teams, however, this did not result in the creation of cycles of segregation of specialists, on the contrary, it brought organization to the flow of

tasks and the teams were able to work collaboratively.

The report above made by one of the developers (E6) is very close to the perception described by one of the operations analysts (E9).

5 THREATS OF VALIDITY

We classified the threats to the validity of this study, according to Runeson and Host (Runeson and Höst, 2009).

Construct Validity. This threat concerns the participants' understanding of the research objective and the clarity of the interview questions. It also relates to how effectively we communicated the research purpose during the interviews. To address this, we conducted a pilot interview with a PhD researcher and an industry professional, who evaluated and validated the instrument, highlighting only minor adjustments. Nonetheless, during the actual interviews, several participants expressed confusion about the instrument. To address this, we provided additional explanations to improve its clarity and ensure a better understanding.

Internal Validity. This refers to the credibility of the results, as our study adopts a qualitative approach. The challenges and benefits of evidence-based (EB) practices identified may not fully reflect reality. One notable threat to this construct is the limited size of our interview sample, which may impact the generalizability of our findings. To mitigate this limitation, we specifically selected professionals with extensive experience in the field. All interviews were recorded and subsequently transcribed, enabling multiple reviews of the data to ensure the rigor and reliability of our analysis.

Reliability. This pertains to the replicability of the results. To enhance transparency, we ensured that our data analysis process was clearly documented. We have included an attachment containing the interview guide used, along with the evidence that underpins our findings, to facilitate reproducibility and support validation of our results.

6 CONCLUSION

This paper presents the results of a case study relating to the integration between DCU and ASD during development of appointment subsystem of HIS. We contribute to the improvement of requirements engineering by providing:

1. Practical insights into user-centered agile development.

2. Empirical research regarding the challenges of integrating UCD and kanban as ASD (see C1-C7, 3.3) in a real-world context.

3. A proof that our approach covers the integration of UCD and ASD as a kanban context.

The process model used in this paper, followed by the guidelines proposed by Schön, 2016 (Schön et al., 2016), where the ideation/UX requirements gathering tasks were organized in a design kanban board, separate from the development board, where objective is to organize the flow of activities and increase transparency relation to user research, design and UX, as well as usability inspection activities under produced artifacts to improve requirements elicitation. Requirements were continuously evaluated and flowed through the development process in a structured manner and with fewer usability problems.

We can conclude that the integration of UCD activities into Kanban through multiple boards leads to a product with a good UX and makes the development process more user-centered. Users of the developed electronic appointment scheduling system are satisfied and their needs have been met. There was good freedom on the part of project members after adopting the development process, as well as greater and more effective cross-functional collaboration between the design and development teams, which helped to accelerate product development.

7 FUTURE DIRECTIONS

- Although our work provides significant contributions to creating value at ASD, we acknowledge that these contributions are still in their early stages. Therefore, we propose a series of future directions that can build upon our findings: .

- There is a research opportunity to understand how the adoption of intelligent artificial resources can contribute to improving usability and the integration between ASD and UX.

- Expand this research to assess the contribution of Intelligence artificial intelligence and Machine Learning on the integration between ASD and UX.

- Future research could explore the impact of remote work on the integration between ASD and UX in the development of healthcare software, particularly in the context of changes brought about by the COVID-19 pandemic.

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APPENDIX

Multimedia Appendix A

Metadata of interview questions.
[PDF File , 65 KB-Multimedia Appendix A]
https://drive.google.com/file/d/1MHDY78blSpfn tK-bcC8uEKWiG3ShgwnmL

Multimedia Appendix B

Metadata of inspection checklist.
[PDF File , 367 KB-Multimedia Appendix B]
https://drive.google.com/file/d/1GtRixMGq29n27g PlCp8JxuHlhjtBN1zF