

Agile Design Process with User-Centered Design and User Experience in Web Interfaces: A Systematic Literature Review

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Abstract—In the search for faster software development techniques that consider user’s needs, agile methods are getting space in the corporate scenario, as well as in scientific research. However, integrating agile software development with user-centered design (UCD) and user experience (UX) is a challenging task. In this way, we systematically reviewed the literature until 2017 to identify and understand how UX can be considered in agile development, particularly for graphical interfaces of web applications. The search was performed in the ACM, IEEE, Science Direct, and Springer databases. We found a total of 815 studies, of which 13 met the eligibility criteria. This research is important for evidencing the information acquired and used to map how agile methods can consider the stakeholders, activities, and techniques that directly imply the way the products are developed to meet the user’s expectations. There are many agile methods, each with its advantages and disadvantages, but we conclude that the methods that integrate better with UX or UCD are Scrum and XP.

Index Terms—Web graphical interfaces, Agile Software Development, User Experience, User-Centered Design.

I. INTRODUCTION AND BACKGROUND

Agile methods have become popular in recent years for delivering positive results and rapid changes in software development. Even so, not all the projects implemented using agile methods are considered to be successful. One of the reasons for project failure is the adoption of the wrong agile method since this choice is a challenging task [1].

The effects of agile software development, according to Chuang et al. [2], are immediate feedback through customer engagement, adaptation, and effective response to changes, among others. In addition to incremental value delivery, agile software development can increase the business value and facilitates achieving of the company’s goals. Agile methods are anchored in an iterative and incremental development cycle that quickly produces functional application versions that deliver value-based solutions to the customer [3].

However, Dingsøy et al. [4] mention some of the remaining challenges, such as identifying the most efficient agile methods, adopting agile methods in distributed projects, and the need for theoretical foundations when investigating the agile

development and its various practices. Rivero et al. [5] argue that agile software development approaches are now becoming the industry standard for web application development as they emerge as a response to the need to adapt quickly to changing environments. Rodden et al. [6] explain that advances in web technology have enabled more applications and services to become web-based and increasingly interactive. Still, development standards for graphical interfaces in web applications are different from mobile interfaces and other environments [7].

Among the paradigms for the development of interfaces are the User-Centered Design (UCD) and User Experience (UX).

For Garrett [8], the concept of UCD consists of taking the user to each part of the project during development, so that it is tested and evaluated, and these considerations are taken into account for the outcome of the final product.

The International Organization for Standardization (ISO 9241-210) [9] defines UX as a person’s perceptions, responses resulting from the use or anticipated use of a system, product, or service. User experience includes emotions, beliefs, preferences, physical and psychological perceptions, color responses, behaviors and achievements that occur before, during, and after use of the system, product, or service. According to it, UX is a consequence of brand image, presentation, functionality and system performance.

In this perspective, integrating UCD or UX into agile environments becomes a challenge [10], [11]. Changyuan et al. [12] emphasize that UX can guide conception and information, but also provides the basis for improving a platform by assessing the quality of its growing importance. However, for Gordillo et al. [13] there is still a gap between research and practice, since many evaluation methods and studies are kept in the academic field and are never translated into practice, and many software companies are not even aware of UX importance.

Agile methodologies such as Scrum, Kanban or Extreme Programming (XP), provide a process model for developing products. These templates do not define the type of product that meets the needs of users and the expectations of customers. Therefore, to fill this gap and to develop products with a good UX, development approaches are applied using UCD [14].

Dingsøy et al. [4] recognize that the relationship between agile software development and UX is solid. For Chamberlain et al. [15], if agile and UCD methods are successfully integrated within a project team, there will be benefits to both

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business and user. Plonka et al. [16] emphasize that integrating the UX design with agile development continues to be the object of academic analysis and professional discussions. The same authors prove that this integration is always a challenge, no matter which agile method is used.

However, integrated agile and UCD methods add value to the process adopted and to the teams, as Hussain et al. [17] concluded in their qualitative research. The authors realized that adopting the agile design process centered on the user by their teams resulted in the improvement of quality and usability of the developed product. They also concluded that the resulting product increased end-user satisfaction, which is one of the most crucial success factors for an application. Kuusinen et al. [18] point out that further research is needed to integrate agile and UX methodologies.

Given this context, we systematically reviewed the literature to identify studies applying agile methodologies considering UCD or UX for development of graphical web interfaces.

II. METHODOLOGY

This paper shows a systematic literature review (SLR) quantitative, which is a way to evaluate and interpret all available research relevant to a particular research question, topic area or phenomenon of interest, according to Sampaio and Mancini [19]. Systematic reviews aim to present a fair evaluation of a study topic using a reliable, rigorous and auditable methodology [20].

A. Research Questions

The guiding questions of this research aimed to select studies of agile methodologies adopted for web interface development, and that consider User Experience:

- 1) What are the commonly cited agile methods for web graphical interface development that consider UX or UCD?
- 2) How does the integration among the agile method and UX or UCD occur?

B. Search Terms and Databases

Following the PICO strategy [21], the search terms was defined as follows: ((*Agile OR "Agile Method" OR "Extreme Programming" OR Scrum OR Sprint*) AND (*Interface OR Design OR "Web Design"*) AND (*"User Experience" OR "Human-Centered Computing" OR "User Centred Design"*) AND (*"Web Application" OR Web OR WebSite OR Site*)).

For searching, we selected four databases: Springer, Science Direct, Association for Computing Machinery (ACM), Institute of Electrical and Electronics Engineers (IEEE). With the search string, the searches were carried out in the bases selected in 2017. There was no change in the search string, and we considered only particularities of each base. Journal articles, book chapters, and conference proceedings were considered, without date and language restriction.

C. Eligibility Criteria

The eligibility criteria defined and considered in this study for the inclusion of results in the final analysis are:

- 1) Papers that specify at least one agile methodology for web application development.
- 2) The methodology needs to consider User Experience.

D. Studies Selection Process

We conduct the studies selection method in three phases:

Phase 1: Search in the selected databases. The search string was applied to all selected databases, according to the particularities of each one;

Phase 2: Preliminary selection. Reading the title, abstract and keywords of the articles selected in the bases, with the purpose of verifying compliance with the eligibility criteria;

Phase 3: Full reading screening. The studies were carefully analyzed in a complete reading to verify if they undoubtedly met the eligibility criteria, resulting in the papers included for final analysis.

III. RESULTS AND DISCUSSION

The results were analyzed from the selection process and based on the content of the included articles, according to what is presented in the next sections. The selected studies can enable analysis from different aspects.

A. Selection Process Analysis

In the searches carried out in the first phase, 815 articles were identified, of which 670 were excluded because they were duplicated or did not meet the eligibility criteria, that is, if the articles did not specify at least one agile methodology for web application development or if the methodology did not consider the user experience. The remaining 145 have been read completely, and only 13 answered the research questions presented in this study. Fig. 1 shows the flow diagram of the selection process for included studies.

B. Studies Analysis

Through the results obtained, it is possible to analyze the research questions.

1) *Research Question 1: What are the commonly cited agile methods for web graphical interface development that consider User Experience (UX) ?:*

Table I shows which the reviewed studies most cited agile methods for web graphical interface development.

In the search performed, it was identified that the agile methods most cited are Scrum and XP (Extreming Programming). The Scrum Method is quoted in ten studies, and the XP method in seven studies. The DSDM (Dynamic Systems Development Method) and TDD (Test Driven Development) were both cited three times each.

The study of Dingsøy et al. [4] surveyed to identify some essential points in the decade about agile methods. The same

TABLE I
AGILE METHODS INTEGRATED WITH UX AND UCD CITED IN EACH REVIEWED STUDY.

Study	Agile Methods			Paradigms	
	Scrum	XP	TDD	UX	UCD
Kuusinen et al. [18]	✓			✓	
Chamberlain et al. [15]	✓			✓	
Hussain et al. [22]	✓			✓	
Humayoun et al. [23]			✓		✓
Dingsøy et al. [4]	✓	✓		✓	✓
Felker et al. [24]	✓	✓	✓	✓	✓
Changyuan et al. [12]	✓	✓	✓	✓	✓
Carlson and Turner [25]	✓			✓	
Da Silva et al. [26]		✓			✓
Gordillo et al. [13]	✓	✓		✓	
Rivero et al. [5]	✓				✓
Plonka et al. [16]		✓			✓
Salah et al. [27]	✓	✓			✓

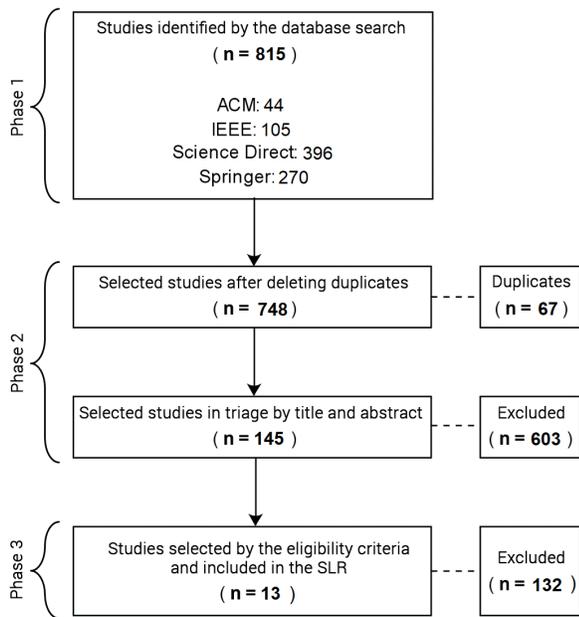


Fig. 1. Phases of the selection process of the papers that were part of the systematic literature review.

study identifies that, after the Agile Manifesto (2001), half of the studies on the subject focused on agile research in general, the other studies focused on XP, TDD (test-driven Development) and Scrum. Finally, he cites companies like IBM, Microsoft, and Adobe that have adopted the agile methods in their projects and obtained benefits.

The research of Gordillo et al. [13] evaluated the impact of Usability and UX on software development. In order to instigate agility in the software development process, some methods based on the agile development principle, such as Scrum meetings and XP, were used. In the end, development team members considered that the most influential factor in development was Scrum based meetings for “usability and user experience evaluation methods”. Some members pointed to practices coming from XP as very useful. An important point to note is that for the developers, meetings that did not follow the Scrum methodology were not considered useful or productive.

The study of Felker et al. [24] aimed to analyze the current

capabilities and future trends of software support for agile ER requirements (Requirements Engineering) based on User Story. The user story comprises three-time aspects known as 3C: card, conversation, and confirmation. Besides, user stories are not considered artifacts of analysis activities, but rather an analysis tool.

In the reviewed studies, in addition to the approach of agile methodologies, some report the use of tools that make the implantation of the methods feasible. As an example, Felker et al. [24] used and concluded that the VersionOne tool, which supports Scrum, XP, DSDM, Agile Unified Process, and hybrid approaches, was the one that best met the criteria selected by the study. These authors selected the VersionOne tool for supporting methodology models for Scrum, XP, DSDM, Agile Unified Process, and hybrid approaches.

The study of Dingsøy et al. [4] pointed to future research that focuses on agile hybrid, distributed teams, focus on theoretical research and knowledge management. In the same way, they point out that research in agile methods focuses more on XP, Scrum, and FDD.

2) *Research Question 2: How does the integration among the agile method and User Experience (UX) or User-centered design (UCD) occur?:*

UCD has emerged from the Human-computer Interaction studies and is a paradigm used by developers and designers to ensure that products will meet user needs [28]. It is correct to say that the use of the UCD paradigm will make the applications have better usability and, consequently, a better UX. According to the Lowdermilk [28], when designing tools using the user as the center of the development process, one can maintain the focus of the end user’s needs and can save development time avoiding possible scope errors.

The UCD process can exist in many variations; it can be incorporated into agile methods, the cascade method, among others. Depending on the team’s needs and experiences, the process can be built with different methods and tasks to meet specific needs.

Table I shows the studies that performed integration among agile and UX or UCD. Among the reviewed studies, the methodologies that were most tested to perform the integration among UCD, UX and agile methods were Scrum and XP.

The Kuusinen et al. [18] study addresses the integration of the Scrum with UX, to enhance the user experience. The case study applied to the Food-co-ops website was a positive experience. Three members participated in the project, which makes the project atypical for the number of team members to be smaller than recommended by agile practices.

The studies of Changyuan et al [12], Gordillo et al. [13] and Kuusinen et al. [18] consider the Scrum methodology to be the most recommended for integration with UX and UCD. Scrum has a clear structure, and it makes it possible to prioritize the desirable resources involved in the project. The planning of each Sprint causes the user to analyze the tasks and the implications of each. The revisions make it possible to identify errors before the implementation, as well as to identify usability problems.

There is a lack of understanding of the role of the UX design in the agile environment. There is little guidance on how to integrate the two perspectives. The study by Da Silva et al. [26] describes the different roles that design will have in the agile environment, improving the understanding of the integration of the areas.

Chamberlain et al. [15] propose the development of a framework that integrates UCD practices with agile development through an ethnographic observation. In this study, qualitative research was carried out taking into account the studies of people and their cultures, their anthropological and social characteristics, the importance of knowing who the users are, of understanding their priorities and goals and actively involving them in discovery requirements. The agile methods used in this study were Scrum and XP. Users gave feedback and tested prototypes, were interviewed, observed and questioned for the research, and their interaction with the product was taken into consideration in details. Collaboration between individuals within the team, especially the collaboration between designers and developers was very significant. The usability engineer noted that design prototyping goes faster than development since development languages are slower for prototyping. The designers worked at a different pace from the developers, which made it harder to iterate their versions. For the authors, the current tools simplify the generation of more generic prototypes, which reuses blocks that were used before, with little alteration for visual purposes only. The prototypes development require more time because it is necessary to implement logic with programming languages, and the validation tests that are required for the user to approve what has delivered.

The research by Chamberlain et al. [15] addresses five principles for integrating UCD into agile development:

- Involvement of users: the user must be involved in the process;
- Collaboration and culture: designers and developers should be willing to communicate and work together and on a daily basis. The client must also be an active member of the team;
- Prototyping: designers must be willing to “feed the developers” with prototypes and user feedbacks in a cycle where everyone is involved;
- Project life cycle: users’ needs must be discovered before something is developed;

- Project management: the integration must exist in a cohesive framework that facilitates without much bureaucracy and without imposing many rules.

UCD is an approach that aims to engage users in a meaningful and proper way throughout the development of a system. According to Chamberlain et al. [15], the successful integration of agile and UCD methods within a project team, bring benefits to the business and user.

For Plonka et al. [16], integration can be divided into two categories, as follows:

- 1) Bring people closer to each other, integrating and socializing, where professionals can share information about their roles with each other and divide their workspaces, generating more interaction. For this to be possible, it takes an interdisciplinary work
- 2) The second category of integration is to align development with UX design practices, causing each development iteration to be validated considering user experience expectations.

According to Plonka et al. [16], in the XP method, the practice of one team is recommended. This view is problematic when the methodology is applied in the integration with UX. According to the author, it is not desirable to join agile designers and developers, since UX designers work better when separated from the problems of software construction, considering that these issues hinder creativity, alignment of development and design practices. So that the development team is aware of and aligned with the design team and this job is a valuable practice.

Design techniques such as creating *personas* can serve as techniques for developers when they ask for those who are developing. So that there is a reference that facilitates the progress of the project, keeping the focus on the end user, based on people previously defined. Designers with a focus on solving design doubts, minimizing future rework, can use agile methods such as question boards, which show the possibilities of user interaction with the system.

Hussain et al. [22] propose the integration of XP with UCD to develop a mobile application of streaming. The integrated process allows to combine the benefits of both and makes it possible to reduce the failures of each since XP needs to know its right end users and finds the answer to those questions in integrating with the UCD.

According to the study of Hussain et al. [22], a comparison between XP and UCD was created to understand the methodologies better and identify at what moments they relate and benefit:

- Both solve different problems, but when comparing values, the two modes of development can benefit each other’s practices.
- One of the practices of XP is to have the customer on site, to give feedback on the system. This practice can be combined with prototype testing with real users as proposed by UCD.
- Constant and extensive tests are the core of XP. Testing with end users is a valuable source (to find potential errors).

- Iterative development happens in both (in different ways).

In this way, they concluded that the XP process combined with the UCD practice due to the iterations of both. The UCD process focuses on users through the design and development of a product. The most significant success cause of an application is user acceptance, as demonstrated by Hussain *et al.* [22].

Salah *et al.* [27] present the Agile User-Centered Design Integration (AUCDI) model. The AUCDI is based on some processes achieved through the implementation of a set of practices perceived as subtasks of a process. These processes are UCD planning, user analysis, task analysis, identification and understanding of user needs, identification and understanding of UI design requirements, light documentation of synchronization among UCD practitioners and developers, interaction design, user task design, and usability evaluation. The AUCDI process involves customers, users, developers, UCD and XP professionals. This study is the first found that brings a descriptive Maturity Model in the subject.

Humayoun *et al.* [23] present a framework to join the UCD philosophy into an agile process through a three-level integration. One of the challenges in software development is to engage end users in the design and development stages to efficiently collect and analyze behavior and feedback and follow development accordingly. UCD is used in software projects with the goal of increasing product usability, reducing the risk of failure, lowering long-term costs and increasing quality in general. The UCD philosophy puts the end user in the center.

The framework proposed by Humayoun *et al.* [23] presents a form that emphasizes a firm integration in which ideas are combined at all levels. Agile methods and user-centered design processes differ in nature and are developed in different environments and disciplines. The levels covered are life cycle level, iteration level and level of the development environment.

The case study conducted by Humayoun *et al.* [23] is applied in six development teams, performing an application called FTSp. Each team developed its version of the same application. A total of 12 experiments were conducted for evaluation. Among the comments, they mentioned the excellent collaboration between the team and the participants, the benefits of recognizing new problems that had not been seen before.

In the other case study also by Humayoun *et al.* [23], six teams developed the software design using agile methods, using TaMULATOR to evaluate the developed project. The final evaluation was a quality test, with satisfaction levels of 1 to 5, where five was very satisfied. Thirty-two team members responded, and the average grade was high. Team members referred to the importance of learning and dealing with usability as it develops. The importance of developing a framework to integrate the user-centered design philosophy into agile practices is that the framework promotes a set of attributes to select and evaluate the methods at each iteration.

According to Da Silva *et al.* [26], UCD uses a lot of time and effort in research and analysis before the beginning of development, and the agile methods are dedicated to delivering small parts of the functionalities in each iteration. Both are

iterative, and customer focused. The authors show that the UX can show the success or failure of the product. In this work, the first designs stages were very detailed without a need for it, and the change of scope can lead to a waste of perfection of worked design. Some problems with the design will only be met when the implementation begins. Very “Pixel Perfect” design can increase resistance to changes. Design quality can benefit since the developer with knowledge in the platform presents its style guides to the design.

Overall, the integration of UX design and agile development is always a challenge, no matter which agile method is used, bringing advantages and disadvantages.

From the reviewed studies, advantages and disadvantages are shown in the Table II, while the challenges are shown in the Table III. The most significant problems in Agile UX were lack of cooperation between the UX experts and developers, and the lack of time stipulated for UX design. It is essential to understand the whole problem and the concept of creation before starting the development of a project.

Kuusinen *et al.* [18] bring the state of the art of agile UX into a multi-continental software development organization. The research showed that most of the problems related to communication.

Kuusinen *et al.* [18] explain that results of the application of agile methods with UX are not conclusive in that the organizational part is addressed rather than methodological issues. Consequently, further research in this field is needed in order to perfect the agile methods to improve UX related issues. There is a clear need for more UX studies integrating with agile development. Therefore, they conclude that there is a need to study more to understand the best working practices of Agile UX.

IV. CONCLUSIONS

In this review, we mapped 13 studies that prove the challenges in the Web interface development using agile methods with UX and UCD.

The selected studies answered the two research questions addressing agile methods and its integration among UX and UCD, in addition to the challenges, advantages, and disadvantages in this integration.

The obtained result provides a mapping for future research integrating agile methods for the Web interface development considering the user experience.

There are many agile methods, each one with its peculiarities, but it is concluded that the methods that integrate better with UX or UCD are Scrum and XP. It is notable that there has been an advance in the agile methods application and Web applications development, however, there is a deficiency in choosing the right method that meets the expectations.

There is a clear need for more UX studies integrating with agile development. Therefore, we conclude that there is a need to study more to understand the best working practices of Agile UX.

Finally, as a continuation of this research, based on the results of this systematic review, it is to verify how the integration of agile software development by small teams with

TABLE II
ADVANTAGES AND DISADVANTAGES RELATED TO THE INTEGRATION OF AGILE METHODS WITH UX OR UCD.

	Feature	Description	Studies
Advantages	Productive Meetings	Fast and focused.	Gordillo et al. [13] Rivero et al. [5]
	Clean Method	Easy to understand.	Gordillo et al. [13] Felker et al. [24]
	Focus on the project	Value in the business and focus on customer value deliveries.	Gordillo et al. [13] Carlson and Turner [25] Plonka et al. [16]
	Target on projects	Manageable sprints with short cycles.	Gordillo et al. [13] Carlson and Turner [25] Plonka et al. [16]
	Reduction of Errors	Analysis of Sprints enables continuous feedback. Identifying errors so they do not recur.	Felker et al. [24] Plonka et al. [16]
	Use of Mockups	Increased efficiency in collecting requirements.	Rivero et al. [5] Carlson and Turner [25]
	Sprint planning	Know the next tasks.	Felker et al. [24]
	Continuous improvement	Transparency and Trust generates progressive improvement.	Rivero et al. [5]
	Shared vision	Dynamic teams and collaborative work.	Carlson and Turner [25] Plonka et al. [16]
	Manage knowledge Retrospectives are positive	Organizational Learning. Analyze positives and negatives.	Dingsøyr et al. [4] Gordillo et al. [13] Felker et al. [24]
Disadvantages	Lack of cooperation between UX experts and developers	Share information, knowledge regarding the project.	Kuusinen et al. [18]
	Have instructor in agile methods	Initially have an instructor to “teach” the agile process, to facilitate acceptance.	Carlson and Turner [25]

TABLE III
CHALLENGES RELATED TO AGILE METHODS AND USER-CENTERED DESIGN (UCD).

Challenge	Description	Studies
Bring teams closer	Bring closer teams with diverse skills and roles.	Carlson and Turner [25]
Large teams	Distribution and job management become more complicated.	Carlson and Turner [25]
Organizational change	Understanding agile culture.	Carlson and Turner [25]
Conservative culture	Professionals resist “exposing” their work (fear of losing status).	Carlson and Turner [25]
Not enough time for UX design.	Delayed design causes delay in implementation.	Kuusinen et al. [18]
Understand the problem in context	Understand the business and what the customer needs.	Kuusinen et al. [18]
Communication between developers and UX design	Maintain communication channels. What information, how and when to communicate it.	Plonka et al. [16] Kuusinen et al. [18]
Developers and designers have different perspectives and objectives	Different skills and knowledge.	Plonka et al. [16]
Design accuracy level	Very detailed initial design with no need.	Plonka et al. [16]
Embedding UX design functionality	Meet user’s expectations.	Plonka et al. [16] Felker et al. [24]

a turnover. For this integration we will consider the user experience, that is a challenge due to the need to understand how UX and the UCD can be incorporated into agile development processes into university research groups where the team is in the process of academic training.

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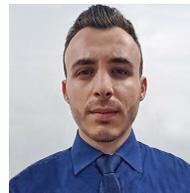
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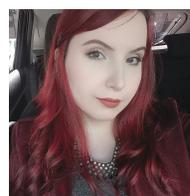
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