Challenges of Integrating Agile and UX/UCD: Systematic Literature Review

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ABSTRACT The integration of Agile development with User Experience (UX) and with User-Centered Design (UCD) grabs IT companies' attention and has become one of the most significant topics in the last few years. In agile UX/UCD processes, the software development process is positively impacted. This systematic review of the challenges of integrating Agile with UX/UCD is provided here to assist other researchers in identifying the recent major challenges associated with Agile and UX/UCD. In addition, this review covers articles available in five research databases. Based on the search strategy, 73 studies were identified relevant to the scope from 2001 to 2021. The findings of this review provide insight into the research area of Agile UX/UCD and also offer future research directions.

INDEX TERMS agile software development, user centered design, systematic review, agile user center design integration, agile user center design challenges

I. INTRODUCTION

Agile development and UX/UCD have become conventional concepts in software engineering. It is essential to understand how the integration of these two concepts can improve the entire development process and increase its efficiency and effectiveness [1]. Therefore, Agile methodologies such as Scrum, Kanban, and Extreme Programming along with UX/UCD, provide a process model for product development. However, there are shortcomings and challenges associated with the integration process related to time constraints, work balance, modularization, feedback, prioritization, and documentation that need to be addressed. In order to improve each of these challenges, a variety of methods and modules must be employed.

The aim of this systematic literature review is to identify the challenges associated with the integration of the two concepts and explore how those challenges have been addressed. In addition, the review describes how recent studies have integrated these two concepts. In particular, this study aims to explore the most used UCD techniques in agile development. In addition, it attempts to examine the agile methods that adopt UCD techniques.

The remaining sections of the paper are structured as follows: Section II describes the methods used to conduct this study. Within the same section, introduces the research objectives, research questions, and review method which includes a description of the search strategy, selection process, and quality assessment. Section III discusses how the articles will be classified. Section IV summarizes the main findings of the study. Hence, it provides a summary of the included studies and answers to the research questions. Finally, section V discusses the significance of the findings and the limitations of the study.

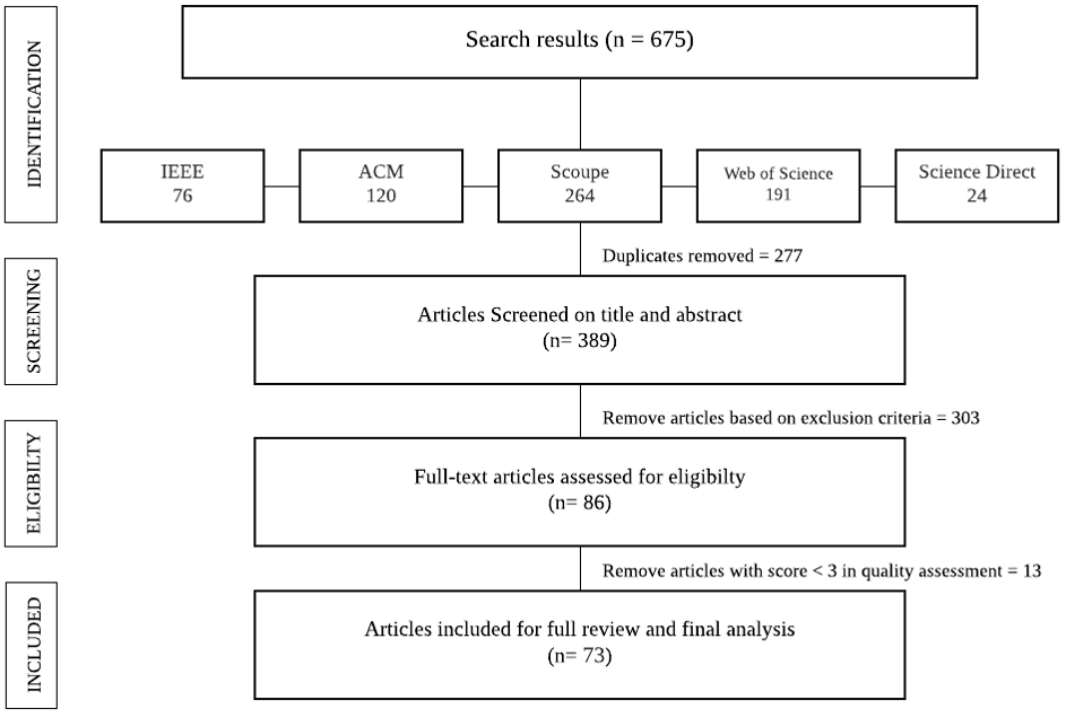

FIGURE 1. **PRISMA flow chart.**

II. METHODOLOGY

This section presents the method used in this study. First, research questions are provided. Then the research strategy is explained as well as the inclusion criteria. This section then concludes with the quality assessment process. In addition, the systematic review of literature was performed through applying the preferred reporting items for systematic reviews and meta-analyses (PRISMA) protocol [2]. Figure 1 provides details of the PRISMA flow chart, whereas Figure 2 demonstrates the detailed search and selection process. The charts presented in this section were created through Lucidchart [3].

A. RESEARCH QUESTIONS

To conduct this systematic review, the first step was to identify the research questions. This study was undertaken to review recent studies in the area of integrating agile and UX/UCD with a focus on the challenges. Therefore, four research questions were defined as follows:

- RQ1: What are the most used UCD techniques in agile development?
- RQ2: What are the agile methods that adopt UCD techniques?
- RQ3: How does the integration among the agile method and UX/UCD improve the process?
- RQ4: What are the challenges of the integration of Agile and UX/UCD?

RQ1 aims to gain insight into different UCD/UX techniques that have been applied in agile. RQ2 aims to gain insight into different agile approaches that have been combined with UCD practices. RQ3 aims to investigate how processes can be improved when Agile and UX/UCD are integrated. RQ4 aims to identify challenges associated with integrating Agile and UX/UCD.

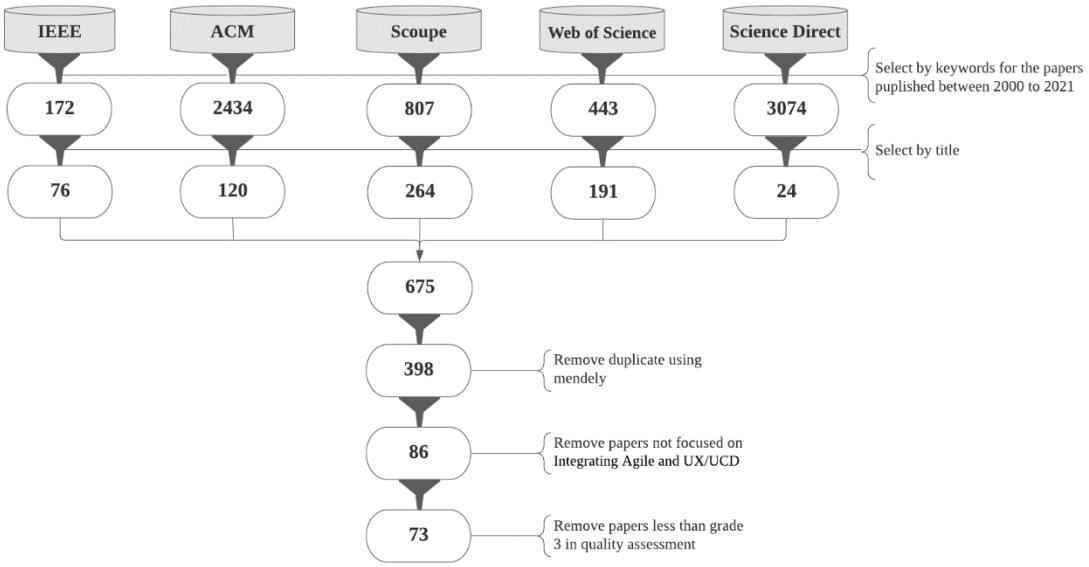

FIGURE 2. Search and selection process.

B. SEARCH STRATEGY

The network analysis interface for literature studies (NAILS) [4] was utilized to gain an overview of the publications in the Agile and UX/UCD field. NAILS is a free open-source software used to analyze literature studies. It has been used to analyze about 454 articles published on agile and UX/UCD from 2001 to 2021 as illustrated in Figure 3. Moreover, NAILS software also analyses publication information from the Web of Science and delivers detailed information on the timeline of publication. The literature on integrating Agile and UX/UCD has expanded in 2013. The software also provides detailed information on the authors in the field, such as the most prominent and most cited authors in the field. Such information can be sorted by the total number of citations and the number of articles published. It also shows the important articles according to the most popular and most cited articles. In addition, the software provides essential keywords, i.e., the most popular and most cited. These keywords are normally sorted by the number of articles in which they were mentioned as well as by their total number of citations. Furthermore, the sorting of articles can be performed by the top 25 through three measures of significance: i) in-degree in the citation network, ii) citation count obtained from the Web of Science, and iii) PageRank score in the citation network.
Following the overview analysis, the search was conducted by searching for conferences and journal articles from five databases, which included:

- *IEEE Xplore Digital Library*
- *ACM Digital Library*
- *Scopus*
- *The Web of Science*
- *Science Direct*

The specific search in each database was by using titles with keywords as in the following: ("Agile software development" OR "Agile methodology" OR "Scrum" OR "Extreme Programming" OR "Agile") AND ("user experience" OR "user interface" OR "user centered design").

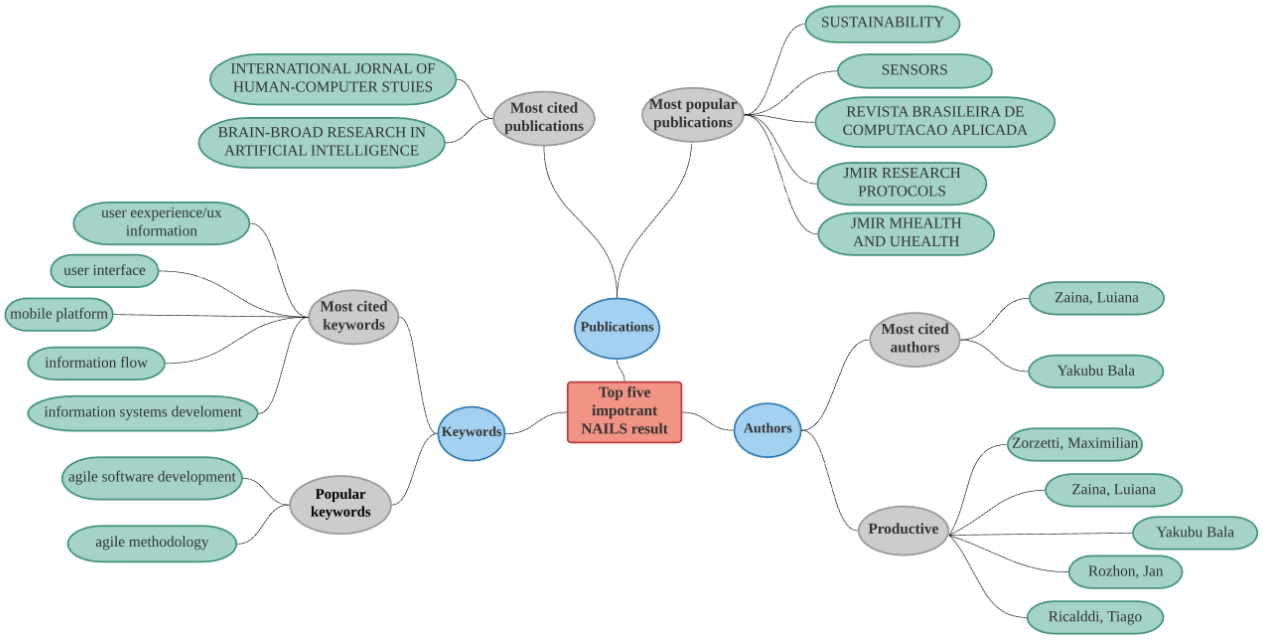

FIGURE 3. **Summary of NAILS results for Agile and UX/UCD publications for 2001-2021.**

C. STUDY SELECTION AND INCLUSION CRITERIA

The results of this study were obtained and sorted using Mendeley Reference Management Software. The inclusion and exclusion criteria were identified for the articles in the present study as illustrated in Figure 4. The inclusion criteria were:

- The article was relevant to the topic of Challenges of Integrating Agile (UX/UCD).
- The language examined in the Agile article was English.
- The article focus was related to the RQs.
- Article published during the period 2001–2021.
- Studies available in full text and retrievable online.
- Articles with a quality assessment grade of at least three (As defined in this study).

These criteria were applied to filter the articles. The research's focus was on recent articles in integration of Agile and UX/UCD; therefore, the first criterion was to include articles published during the period 2001–2021. This criterion was applied using the databases' research boundaries. The second criterion was to filter the articles that demonstrate the integration of UCD/UX processes with Agile methodologies. In the articles that examine the challenges in integrating agile and UCD/UX, the article's focus had to be related to the RQs. This criterion was utilized using Mendeley software. For integration articles that investigated challenges, the focus of the article was on the RQs. In regards to this criterion, Rayyan [5] was utilized. Rayyan is a web application that presents information of the published article along with the abstract that helped the authors of this systematic review. This is performed to collaborate and vote on articles according to the RQ criteria. There were three voting options: include, exclude, and maybe. In addition, Rayyan allows hiding the voting of individuals from other users. Seven authors utilized the Rayyan website for the purpose of evaluation, and each article was voted on anonymously by two users. Each criterion was performed separately as illustrated in Figure 2. All articles that fit the other criteria and which received two "include" votes and "exclude" and one 'maybe" were ruled out. Articles that had two "maybe" vote and one "include" and one "exclude" were further checked by a third reviewer. In these cases, the third reviewer makes the final decision regarding the inclusion or exclusion of the article.

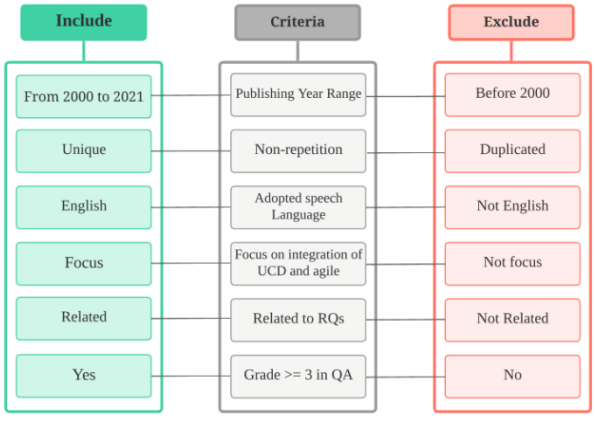

FIGURE 4. **Search and selection process.**

D. QUALITY ASSESSMENT

The quality assessment process shown in Fig. 5 was based on the following predefined quality questions

- Are the aims of the research clearly stated?
- Does the paper provide integration of Agile and (UX/USD)?
- Does the Agile integration with (UX/USD) improve effort?
- Does the article provide answers to the formulated RQs?

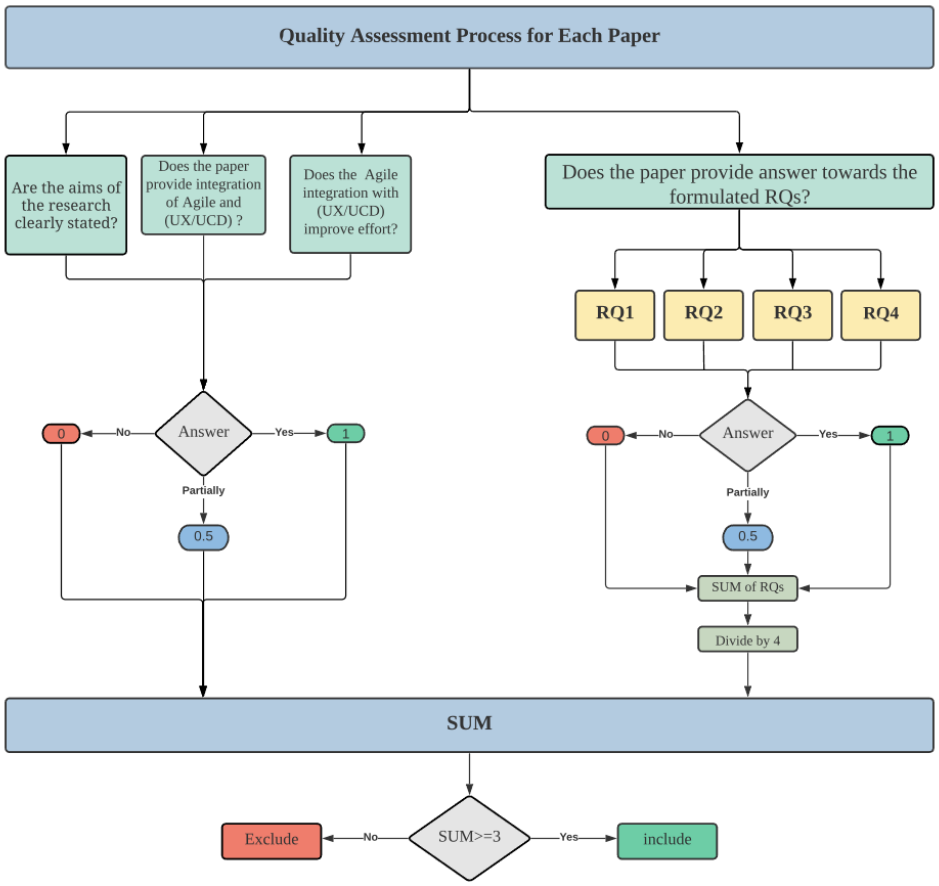

FIGURE 5. **Quality assessment process.**

Each quality assessment question answered in the affirmative was given one point against the quality score. All authors were included and evaluated the articles based on the quality questions and related research questions. Research articles that had a quality score greater than or equal to three were selected. The assessment process was as follows: If the article addressed the question completely, it was given one point, and 0.5 points if the question was answered partially, whereas zero point was given to articles that did not answer the question. Since the fourth question was a composite, it was further divided into sub-questions according to the main research questions. Each sub-question was allotted a score, and the result at the end was divided by four to obtain one overall result for that item. Following that, the points were summed for all quality questions. If the research article obtained a non-integer total score, it was then rounded to the nearest digit. For example, a 3.4 would be rounded to 3. Only research articles with total scores of three and above were considered in the criterion.

III. CHARACTERISTICS OF THE ARTICLES

To cover the trends of the articles, Figure 6. Below illustrates the selected articles for the current study according to the year of publication. The characteristics of the reviewed articles are provided in Table 1.

A. CLASSIFICATION OF ARTICLES BASED ON TECHNIQUES

1) **Little Design up Front:** Several design techniques have been adopted into Agile development, such as Little Design up Front as the commonly used practices for upfront design was the “sprint zero” approach. In [6], the author used persona at the beginning

of the project, particularly in cycle zero. According to the author, this assists with summarizing and describing target users and workflows in brief and vivid terms. In [7], the authors described how a one-day design studio fuses agile development team practice with user-centered design. They conducted a case study to examine the concept of a studio approach to interaction design in the context of agile User Experience Design. By using a design studio approach, the entire team was able to gain a solid understanding of the design so that they could start development and to strengthen their collaboration. A pre-development usability evaluation was conducted in [8] as during Sprint 0, user stories and high-fidelity prototypes were created in addition to identifying the key users.

CLASSIFICATION OF ARTICLES BASED ON TECHNIQUES					*CLASSIFICATION OF ARTICLESBASED ON PROCESSES*					*CLASSIFICATION OF ARTICLES BASED ON PRACTICES*	*CLASSIFICATION OF ARTICLES BASED ON DIFFERENT APPROACHES*		
Little Design up Front	Prototypes	Personas	Work shops	Usability testing	Scrum methodology	Extreme Programming (XP) methodology	Feature-driven Development methodology	Parallel track	Hybrid methodology		New Framework	New Model	New Team role
[5]	[8]	[14]	[15]	[17]	[18]	[23]	[24]	[5]	[26]	[29]	[30]	[29]	[40]
[6]	[9]		[16]		[19]	[14]		[19]	[27]	[22]	[31]	[35]	
[7]	[10]				[20]			[25]	[28]	[13]	[32]	[36]	
	[11]				[10]			[13]			[33]	[37]	
	[12]				[21]			[8]			[34]	[22]	
												[38]	
												[39]	

TABLE 1. **Classification-wise breakdown of the reviewed articles.**

2) **Prototypes:** Prototypes were used for a variety of purposes, but mostly to test a design, as in [9] The authors used low-fidelity paper prototypes as well as high-fidelity prototypes to perform evaluations and usability tests. Similarly, another study [10] developed a technique that combines prototyping with two of the most essential software quality criteria, usability and user experience (UX). As a result, this technique was created to be used by agile teams regardless of the number of resources available, the size of the project, or the agile methodology used. The researchers used prototyping technique in [11], to make it easier for the team to understand the design when seeing the prototype sketch. Therefore, prototypes are great tools for making design decisions when there are multiple design solutions available. For this reason, they conducted two types of tests in the initial phase, prototype testing and iterative redesign usability evaluation, involving eight members of the research team. The results showed that prototyping and usability heuristics are presented as a fast and cost-efficient, yet still effective and accurate method of evaluating the user experience of educational software. A Low-fidelity prototype was utilized in [12] which nine screens were identified and designed as part of the screen interface. In order for this prototype to become a real system, it must be usable by users who can provide feedback. Therefore, the prototype must reflect actual simulated user scenarios. Consequently, the application was successfully implemented according to the project scope and methodology. In addition, the usability has grown virtually as the users can use the application without assistance or instructions. Wireframes were used in [13] as part of the process for redesigning their current website, providing a concept for the layout, structure, and navigation, as well as for organizing content and prioritizing content, then the validated wireframes were turned into a mockup.

3) **Personas:** In [14], the authors have used personas to develop a detailed description of the planned application as three primary personas have been emphasized, which resulted in the successful implementation of the application in accordance with its scope and methodology.

4) **Workshops:** A collaborative workshop called Design Studio was used in [15] to demonstrate the benefits of incorporating agile into the UCD process. Developers and designers attend design studios to discuss their work, ideas, and feedback in order to have a common understanding. Workshops were used in [16], where the product manager initiated them for everyday contact with the team. Workshops are intended to shift the product manager's perspective on how user stories should be applied in an agile environment.

5) **Usability testing:** A formative usability testing was used in [17] to propose an integrative approach that integrates the agile methodology and the UCD to create real-world social robot applications. The usability testing used to evaluate each system iteration with variety of participants to eliminates usability problems early on and its focus on produce useable prototype with a high quality.

B. CLASSIFICATION OF ARTICLES BASED ON PROCESSES

1) **Scrum methodology:** Several articles have adopted UCD techniques in scrum approach. In [18], the authors adopted Storytelling and prototypes into scrum approach to develop an assistive technology which enabled the user advocate to be more involved in exploring the users' needs without delaying the development of the software as well as the development team was aware of the usability without spending copious amounts of time thinking about it. The authors stated that this approach is effective for designing systems for and with hard-to-reach populations. The authors in [19] combined the scrum approach with a formative user experience evaluation to improve the design instead of drawing conclusions about the system. They indicated that this integration ensures the project remains organized and emphasized the creation of a usable product. In The Development of One Stop Service Online System based on User Experience Design and AGILE Method [20], the aim was to design and develop a One-Stop Service system for Educational Media and Technology Services, which consisted of two phases, the first of which involved designing and developing the system in accordance with user experience and using agile methodology, while the second phase involved evaluating its efficiency and usability. Scrum technique was chosen as agile methodology, which involves repeating the process for each incremental change over an iterative process. It started with the integrated UX and Agile processes, which were present in UX:Agile's output line: 1) understand, research: sprint planning, 2) sketch: design, 3) design: develop, 4) implement: test, and 5) evaluation: review. Another study [11] presented a scrum-based development approach that incorporated many characteristics of user-centered design, such as the involvement of experts and users in the analysis, design, and implementation as well as paying special attention to their feedbacks toward additional changes and features in subsequent sprints. The result demonstrates that when applying this process, the interactive design is improved to design comprehensive educational programs. In [21], the authors applied the scrum approach in two cases. In the first case, they used scrum to update and modify the previous version of the product. While in the other case, they used scrum to develop a new project for a new client. In addition, they employed SCRUM to fit the call for tendering document (CFT) and the project contract.

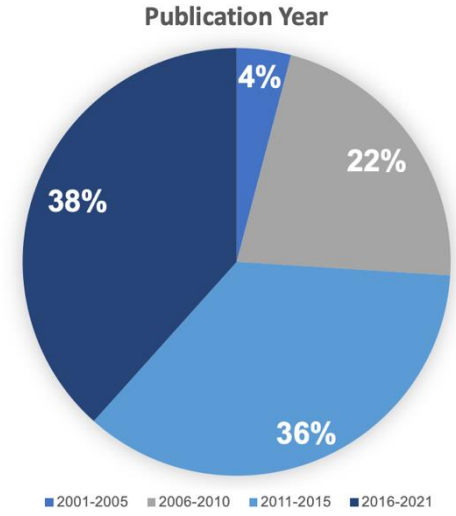

Figure 6. Publication year for the selected studies.

2) **Extreme Programming (XP) methodology:** UCD has been incorporated into Extreme Programming (XP) approaches by several articles. The authors in [22] proposed an approach for integrating UCD and XP development by evaluating the usability of user interfaces as applications are developed in small iterations. In their study, they used various HCI techniques, such as user studies, personas, usability expert evaluations, usability tests, and lightweight prototypes to evaluate the usability of user interfaces. The authors claimed that by integrating both processes, it is possible to combine the benefits and minimize the failures of each, as XP needs to know its right end-users, and integrating with UCD provides the answers to these questions. The authors in [14] proposed an approach for integrating UCD and XP development by adopting prototypes to develop a Halal-Checker mobile application. As a result, the Halal-Checker Mobile Application was successfully in lined with the project scope and methodology. In addition, users were able to access the applications without assistance or instructions, and the feedback from the prototype testing was consistent with the simulated user scenarios.

3) **Feature-driven Development methodology:** A single artic have incorporated UCD methods into feature-driven development approaches. In [23], the authors proposed combining UCD and FDD to present first impressions of the look and feel, as well as to acquire the hands-on experience of prospective community members at an early stage. With their integrated UCD and FDD processes, they have developed a system that can be considered a general tool for users across different contexts. The results showed that the proposed approach helped to iteratively create a product that addresses the users' needs and requirements and eliminates any defects in a timely manner.

4) **Parallel track:** A parallel track approach was used in [6], as in each iteration cycle, designers and developers worked together seamlessly so that designers could gather requirements and design for the next iteration cycle while testing the previous iteration's work. In [19] the author used a parallel track development model in an undergraduate summer research project, that recommends conducting UX testing a Sprint before the implementation as this model helped them efficiently combine design and implementation. Despite that, they wasted some time at the end of the summer when they did not get to implement a feature that they carefully planned of time. In [24], the aim was to collaborate user experience and development teams in a cross-functional way. The process consists of two tracks: Discovery and Delivery. Both tracks run continuously and in parallel, with Delivery being a part of Discovery, which helps the development team participate in discovery activities to demonstrate the competitiveness

of the new product ideas and their technical feasibility. The result demonstrates that when applying this process, the team can deliver usable and useful products that satisfy the user's needs. In [25], a parallel track was set up, where the UX scrum team and the development scrum team collaborated at every iteration. This has resulted in completer and more accurate UX stories, allowing UX teams to devote more of their time to their work rather than hunting for requirements. In addition, this projected capacity made it easier to balance additional tasks like bugs repairs and scope adjustments. The authors of [8] used UX integration into Scrum practice to work parallel within a sprint. Developers and UX designer teams work on parallel tracks in order to keep both their activities synchronized. This results in benefits such as designers focusing more on exceptions instead of striving to get the best design right the first time, better design planning, and more accurate quotes for customer satisfaction.

5) **Hybrid methodology** Several articles have proposed different models that integrate Agile and UX/UCD. The authors in [26] integrated UCD into Scrumban which is a hybrid method of both the Scrum and Kanban agile methodologies for better and faster usability design. Scrumban reduces the team workload by breaking down tasks and assigning responsibility. In the proposed method, UI owner is added as a new team responsibility that is responsible for UI design assessment. Combining Scrumban with UCD benefits rapid software development since time is strictly managed and UI design constantly evolves. The authors of [27] employed an agile usability engineering methodology named InterMod in the development process of a real mobile application project. During early stages of development, questionnaires, interviews, observations, thinking aloud, and usability testing of paper prototypes are used to manage user expectations and discover usability issues, so accurate decisions can be made. InterMod has proven its effectiveness through the proper use of time and effort.

C. CLASSIFICATION OF ARTICLES BASED ON PRACTICES

Several articles have proposed different models that integrate Agile and UX/UCD. The authors in [28] proposed a practice-oriented framework that utilizes Pair Programming as an agile practice along with UI design practices. The framework was taken to apply to CS students, as the author also mentioned the framework could be extended to involve industry teams since it has been proven to increase developer and user satisfaction. It therefore has a greater focus on user experience (UX) components while developing the software. User stories were used in [25] which has been written by the product owner (PO), who is responsible for defining required and prioritizing the stories. The UX team employs prototype techniques to confirm if stories fulfill the requirement. A product backlog was used in [29] which lists the most important features or capabilities for developing a bestselling product. When a priority feature is added to the product backlog, the team will focus on the most important or highest priority item first.

D. CLASSIFICATION OF ARTICLES BASED ON DIFFERENT APPROACHES

1) **New Framework:** The use of Agile and UX/UCD in different frameworks has been proposed in various articles. In [30], the authors proposed a novel framework based on the integration of agile approach with user-cantered process to bridge the gap between them. They applied their work to a disaster management Earthquake case study which involves different users with major role in crisis. And, since crisis management systems should be heterogeneous, the service-oriented architecture (SOA) was chosen as supporting architecture. Their framework consists of four main phases (i) Organization and agile business analysis, (ii) Just in Time (JIT) Requirements Analysis and Elicitation, (iii) Iterations Prioritization and Planning, (vi) Release to Iteration. The researchers of [31] introduced the three communication breakdowns in the integration of UCD and Agile that evolved from the literature and previous work of their Smart Campus project. These breakdowns include the contradiction thoughts of user involvement, documentation, iteration. They improved these themes by analyzing a case study of an IT company that defines a communication network and artifact types used such as Mockups and Wireframes, Briefs, Roadmaps, and Technical Analysis. The researchers extended the framework with task ownership theme and argued that communication breakdowns can be focal points for action and decision. They also suggested adopting design thinking and customer engagement. In [32] The authors proposed a three-fold integration framework that adopts and applies UCD philosophy from end-to-end at all levels to fill the gap that agile development teams often lack in terms of integrated development. Their framework consists of three levels: life-cycle level, iteration level, and development-environment level. Their approach identifies best practices for applying UCD alongside agile development processes and gives suggestions and recommendations for how to incorporate UCD into agile software development at different levels. A framework called SIBAP (Script-Based Aspect-Oriented GUI Prototyping) was presented in [33] that reuses prototypes early on until they become the final product. In which designers and developers share the same prototype to reduce the disconnect between them and guide their efforts toward the final product. The study indicated the framework is effective and benefits from a faster development process. In [34] the authors proposed a framework that integrates scrum and user experience design techniques into the software development cycle, along with the Capability Maturity Model of Integration (CMMI) standards and the dimensions described in the Human Factors Institute's maturity model for user experience design. The study indicated that the framework would improve software development.

2) **New Model:** Several articles have proposed new models that integrate Agile and UX/UCD. The researchers of [35] introduced a new combined model that reduces the time it takes for UCDs to communicate their knowledge to the software development team. The model contains four stages, requirement analysis and user study are the first stage were workshop conducted between designers and developers' team to resolve understanding conflict by presenting slides to discuss the new ideas in initial stages. In the second stage, a prototype of the system was developed and evaluated with usability testing. Once a newly developed version of the system is ready for evaluation, a meeting is to discuss usability issues, suggest modifications, and provide feedback. Finally, the system is integrated and incrementally built and is evaluated using an ongoing usability test. An extended sprint model with a limited duration is proposed in [36] that integrates Scrum development with UX workflow. The design sprint 1 outputs are used in development sprint 1, where the design team moves on to sprint 2 to work on the next set of features. In addition, designers are involved at the end of the process to test the final product and ensure that they meet established usability standards. Using this model, the author asserts, time and quality issues can be addressed. A conceptual model for the UX-Scrum integration was presented in [29], which showed how UX designers work within Scrum teams, using three approaches which are: parallel working, working within a sprint, and lean UX. In parallel track approaches, development and UX design teams work in parallel tracks simultaneously to ensure their activities remain synchronized. As for the second approach, it focuses on the collaboration between UX and development teams during a sprint. UX designers can work with product owners or development teams, depending on which sprint is taking place. During a Lean UX approach, the team will be more focused on outcome than output, which generally refers to a product called a Minimal Viable Product (MVP). A maturity model was proposed in [37] that adopts XP, Lean, and UCD to overcome the gap on how to identify whether a team is maturing through transformation. In addition, they aimed to define a method for assessing the maturity of the team at a particular point. The result demonstrated that their model differs from the literature on several points: (i) All decisions are based on experiences, regardless of the expert's intuition. (ii)The team inspires itself and participates in decision-making without the presence of a leader. (iii) There is an anchor role that links the understanding between business and engineering. (iv) Teams constantly strive to use the latest technologies that benefit their cause without using all UCD techniques. The initial contribution could already be useful to software development teams striving to adapt to such changes. A process model was proposed in [38] that illustrates how two industry teams who employ a combined Agile, Lean Startup, and UCD approach to software development work. The teams defined three phases for the entire development process, in order: scoping, which aims to determine the scope of their work; discovery and framing, which entails refining the problem to solve and then determining the best solution to solve it; and iteration, which entails continuously developing and properly implementing the chosen solution. The authors stated that this model can be utilized as a starting point for enterprises to create their own customized integrated strategy. The authors of [39] presented a process model that integrates agile software development with user-centered design and usability techniques. The process model recommends having a common phase where developers and UI specialists participate in activities. In addition, this will facilitate the early detection of design usability problems and design implementation, resulting in a less time-consuming development process, resulting in a rapid development process and more compatibility with customer needs later.

3) **New Team role:** A new role for a team called "On-site user experience consultants" is proposed in [40], the study focused on fixed-price projects that integrate user-cantered design (UCD) in agile requirements (RE). Their solution allows customers to change requirements without extra payment. They also introduced a team role called "On-site User Experience Consultant" (osUX consultant) for a UCD trained staff to work with the users' needs and provide usability consulting during the development process. They also used personas, scenarios in requirements workshops and ramp-up meetings before implementation. In addition, they suggested changing communication habits.

IV. RESULTS

A. WHAT ARE THE MOST USED UCD PRACTICES IN AGILE DEVELOPMENT? (RQ1)

Various UCD techniques have been employed in Agile development. For instance, Little Design Up Front techniques have been implemented in several articles by reserving a cycle zero, or sprint zero, for analysis and design before any actual iterations start. This concept revolves around time-boxing the analysis and design phases for the duration of the development cycle. Persona was used in [5] at the beginning of the project, particularly in cycle zero. A pre-development usability evaluation was conducted in [7] as during Sprint 0 while [6] described how a one-day design studio fuses agile development team practice with user-centered design. A three-fold integration framework was proposed in [31] to adopt and apply UCD from end-to-end at all levels. A collaborative workshop called Design Studio was used in [14] to demonstrate the benefits of incorporating agile into the UCD process. But [15] used workshops where the product manager initiates them for everyday contact with the team. Fixed-price projects in [40] integrate user-cantered design (UCD) in agile requirements (RE) and introduced a team role called "On-site User Experience Consultant" (osUX consultant), used personas, scenarios in requirements workshops. The researchers of [34]

introduced a new combined model that reduces the time it takes for UCDs to communicate their knowledge to software development team.

B. WHAT ARE THE AGILE METHODS THAT ADOPT UCD TECHNIQUES (RQ2)

Based on the literature Scrum and XP are the most common agile methods in combination with UCD techniques where they provide more flexibility in software Iteration than other methodologies. Also, the software team is more familiar with such methodologies. In addition, some articles combine other agile methodologies with UCD techniques such as FDD, InterMod and Scrmban. However, there were a lot of articles proposed different frameworks and models. Such as in [30], a novel framework based on the integration of agile process with user-cantered approach was proposed to bridge the gap between them of agile approach with user-cantered process. Another study [31] has proposed a three communication breakdowns that evolved from the literature and previous work of their Smart Campus project. In [32], the authors proposed a three-fold integration framework that aims to fill the gap that agile development teams often lack in terms of integrated development. Another study [33] presented a framework called SIBAP that aims to enhance the development process. In [34] proposed a framework that adopts Capability Maturity Model of Integration (CMMI) standards that aims to improve the development process. In [35], the authors presented a combined model to reduce the time it takes the UCDs to communicate with the software development team. In [36], a limited-duration sprint model is proposed, which integrates Scrum development with user experience work. As a result of this model, the author claims both time and quality issues can be addressed. A conceptual model for UX-Scrum integration has been presented in [29], which shows how UX designers work in Scrum teams by using three approaches, which are: parallel working, sprinting, and lean UX. A maturity model based on XP, Lean, and UCD was proposed in [37] in order to overcome the challenge of identifying whether a team is maturing through transformation. A process model was resented in [38] that outlines how Agile, Lean Startup, and UCD approaches work when applied to software development projects. Using this model, enterprises can come up with their own customized integrated strategy. In [39], an integrated process model is presented for agile software development, user-centered design, and usability. With this model, early detection of usability problems and design implementation can be achieved, resulting in a more rapid development process and greater compatibility with customer needs in the future.

C. HOW DOES THE INTEGRATION AMONG THE AGILE METHOD AND UX/UCD IMPROVE THE PROCESS? (RQ3)

Agile and UX/UCD integration have been shown to lead to improvements in several articles. The authors of [41] conducted interviews with Agile teams that use User-Centered Design (UCD) and found that Agile enables usability testing on working software and allows to detect and correct usability issues later during the iteration process. In [42], stated that including the User Experience team and incorporating UED principles into the Agile development process greatly outweighs any risk of derailing product delivery. The authors highlighted in [9], that integrating users into the process indirectly improved it through HCI instruments, co-location, communication, and planning meetings and increased the morale of their entire team. The authors of [26], showed that utilizing UCD within Scrum ban allows for more efficient and faster software development and usability design. The authors of [43] demonstrated that discount usability testing that integrates with Scrum can be rapidly accelerated by utilizing low-cost usability evaluations that do not require as much time or effort as complex and statistical methods. As part of the discount usability approach, prototypes, heuristic evaluations, and simplified think-aloud protocols were used to get early feedback from the users. The findings of [34] revealed that SCRUM facilitates the improvement of a process by providing a better understanding and management of the process. The improvement process can be achieved in a sprint or several sprints as each iteration is composed of five steps: planning, designing, executing, presenting the improved process, and presenting the next iteration. As reported in [21], the integrated process between UCD and Scrum demonstrates improvements in the development process, such as reducing reworks, satisfying users, and better collaboration with stakeholders, along with a better understanding of users and their needs. In addition, the integration provides some additional techniques that can be used in other contexts. In [29], it was found that parallel tracks had some benefits, such as designers tend to focus more on exceptions rather than striving to get everything right on the first attempt, better design planning, and better customer satisfaction quoting.

D. WHAT ARE THE CHALLENGES OF THE INTEGRATION OF AGILE AND UX/UCD? (RQ4)

Based on the literature, challenges related to the integration of agile and UX/UCD were categorized into two categories.

1) **Time:** Several articles [43], [44] mentioned that Agile time boxed nature poses challenges on scheduling and conducting usability tests. For instance, in [22], stated that usability tests could not be conducted frequently with end-users. Lack of allocated time for upfront activities was addressed via upfront design, as in [6], used persona at the beginning of the project, particular in cycle zero that helped in planning and gathering customers' data. Another study [7] used a one-day design studio that helped the entire team to gain a deeper understanding of the design, which permitted them to begin development and to improve collaboration. Another solution is using usability engineering techniques, which is a practical way to conduct low-cost usability evaluations that do not require as much time or effort as traditional methods. For instance, an expert evaluation was applied in

[22] that helped to mitigate frequent usability tests. It also has been suggested in [27] that using usability evaluation techniques can reduce development time and effort. It also avoids the cost and effort of reworking incorrect paths.

2) **Work Balance:** Researchers of [45] observed that the issue of Agile Developers and Interaction Designers having to work on a software development project has historically been characterized as a problem of integration.
To overcome this challenge, several techniques were suggested. In [41], the authors demonstrated that screen mockups can improve relationships between software developers and user interface designers. Similarly, another study [46] mentioned that artifacts such as sketches, lists, and stories are vital to collaboration between Agile developers and UX designers. Also, several practices were suggested to overcome this challenge, for instance, a design studio was suggested in [15] which facilitates a two-way knowledge transfer as developers can gain more insights into design, while designers gain a better understanding of how developers work and how their challenges may affect design. In addition, the researchers of [47] have shown that successful integrating Agile and UX work depends on attitudes and practices, such as mutual awareness, expectations of acceptable behavior, negotiation of progress, and general engagement.

Table 2. Future Directions

Year	Paper Ref. No	Proposal for future Articles
2021	[17]	Future work involves improving the performance of the proposed approach by using summative usability testing. Also, more research could be done in the field of merging the summative and formative usability testing into the agile development approach
2020	[38]	The teams utilized diverse methodologies and most likely depicted their work process using a structured, activity-centered approach. A useful exercise would be to perform a similar study but advise the teams in utilizing an organized, activity-centered approach. tools for unstructured representation of their work process
2020	[16]	Future research will focus on realizing how other activities are affected by deliberation and concise user stories in agile software development. Also, on many organizational levels, more studies are needed to explore reinforcing practices for the integration of the agile UX processes.
2017	[26]	The proposed future work is to extend the Scrum ban method to be applied in large scale system with an appropriate board.
2016	[33]	The authors suggested future work to improve SIBAP framework to resolve its limitations and discover different scripting languages features. Also, do further experiments to examine SIBAP framework efficiency.
2016	[16]	More empirical studies in both academia and industry can provide better reliable evidence to support the findings and another same type of case study will be established with different web projects.
2013	[18]	The authors suggested to investigates the scrum methodology with assistive technology and gets new working insights with end-users in HCI domain as future work
2012	[47]	Future work involves exploring more on Agile/UX tools, processes, and methods. Also, investigate how these processes and tools collaborate in social processes. Moreover, the authors suggested analyzing practice in terms of culture.
2010	[35]	The Inter-Combined Model will be used in further projects to test its validity in bridging the gap between UCD designers and software developers as future work.
2008	[46]	Future research will focus on implementing a more comprehensive model and examining other specific collaborations in greater depth.
2008	[7]	As practitioner adoption is critical to the success of UCD the authors suggested as future work to use the design studio approach.
2008	[9]	An optimization of our process will be continuous and further insights will be provided regardless of its ability to enhance the application usability. contextual mobile multimedia content usability study will be conducted to give information about mobile HCI and consumption times and contexts.

Table 3. **Articles Limitations**

Year	Paper Ref. No	Articles Limitations
2020	[38]	Their research has flaws. They employed numerous data sources to verify conclusions and had senior researchers follow each phase of the investigation to mitigate construction validity problems. They cannot declare that the model is usable in other contexts in terms of external validity. They used automated digital technologies to check their modeling efforts' syntactic quality, while semantic quality was improved because of the supervision and modifications of the scholars mentioned and experts.
2016	[33]	SIBAP framework provides some limitations related to scripting languages where prototype behaviors affected by using lack features scripting languages.
2013	[18]	This approach has disadvantage in describing how a participant used the software and the difficulties with the development team. Having different participants physical impairments means they reached the software in different ways. Using videos helped the user greatly when giving feedback to the rest of the team. The second disadvantage is that reliance on the one user to go to care center which caused problems since the user could not be there because of his personal health and transportation issues.
2012	[47]	Findings of this research can if generalized need care and studied does not cover all the possibilities in practice. Agile development approaches are more than Scrum and the ways designers do is different from practice. However, the teams studied are regular teams in practice. The research aim is to find how developers and designers work to discover the mechanisms that may continue on various settings subject to additional studies into practice.
2012	[19]	The project had challenges and the researchers needed to adjust Scrum because there was no official owner or and for time limitation. plans were done constantly, many Sprints were left without completion, drop a Sprint, because of incorrect tasks estimation and the one- week Sprints reduced errors. Using Scrum in a learning environment needs to have detailed task cards for learning and scheduling longer Sprints.
2008	[9]	The usability engineers were not physically attended all the time which if were done can help in overcoming design issues perfectly. Also, because of the time and budget, usability tests were not carried frequently with end-users. however, this was alleviated with the usability expert evaluations.

V.LIMITATIONS

The focus of this research was on selected Agile and UX/UCD studies that examined integration challenges.
The search process was conducted using a limited set of keywords aimed at providing an overview of Agile and UX/UXD integration. This research focused on publications for a finite period from 2001 to 2021. However, it explores several UCD techniques used in agile development. In addition, it attempts to examine the agile methods that adopt UCD techniques.

VI. CONCLUSION

The Agile development process and UX/UCD have become common concepts in software engineering. In this paper, we review the literature on the challenges associated with the integration of Agile and UX/UCD. The studies were reviewed between the years 2001 and 2021, equal to 73, and were gathered from five different research databases: IEEE Xplore Digital Library, ACM Digital Library, Scopus, The Web of Science, and Science Direct. The paper begins with a brief introduction to Agile and UX/UCD. Following that, the research methodology is described, including research questions, search strategy, quality assessment, study selection, and inclusion criteria. Therefore, these study selections are evaluated and organized based on their characteristics. In addition, the limitations of the reviewed studies and future work are investigated and outlined in this article. This review is expected to provide new insights and to shed light on recent research in the areas of Agile and UX/UCD.

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