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Comparative Analysis of Software Development Lifecycle Methods in Software Development: A Systematic Literature Review

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ABSTRACT

In the last decades, various Software Development Lifecycle (SDLC) models have been developed to meet the different needs and challenges in the software industry. The purpose of this research is to analyze and compare some of the most common SDLC methods. After the selection and evaluation process is complete, a literature review is carried out by collecting articles, books, and other sources related to the SDLC method. Several main SDLC methods were selected for thorough analysis. Waterfall, Agile and Scrum are some of the methods. Important factors such as flexibility, speed of development, ability to adapt to changing requirements, and project risk are evaluated. The results of the analysis show that each SDLC method has strengths and weaknesses, and that they are appropriate for a variety of situations. While Agile and Scrum methods emphasize flexibility and teamwork, the Waterfall method provides greater structure and clarity to plans. This study aims to determine the best process method for software development. This literature review provides an in-depth understanding of the features, strengths, and weaknesses of various existing SDLC methods. With a better understanding of these methods, organizations can choose the SDLC method that best suits their project needs, thereby increasing the efficiency and effectiveness of software development. This research resulted in a process method that is widely used in software development, namely the Agile method.

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1. INTRODUCTION

Today's technology users expect a high level of satisfaction when interacting with a product. They expect to be able to use the product without much effort to complete their tasks quickly and efficiently. There are so many types of software development nowadays. Software development is one of the most important functions of software engineering [1] . The main goal of software engineering is to create reliable and high-quality software for users. Software companies develop various types of software according to the needs for easy use by users [2]. In software development there will be an association with a method or process model, the process model in question is a mechanism that allows an abstract representation of procedures, methodologies or steps in any software area [3]. The process model in the software aims to provide guidance for

controlling and coordinating tasks, so that the final product and objectives can be achieved as effectively as possible.

There are several types of models vizincremental, prototyping, feature driven development, RAD, Scrum, Spiral, Waterfall, XP. Method process Incremental is a software method in which a product is designed, implemented and tested incrementally until the product is ready. The development process is represented by a prototype model. The Evolutionary Process Paradigm is an iterative model used to produce more complete software versions [4]. Feature driven development or often called FDD is a process that helps teams achieve consistent and correct work results [5]. RAD is a way to develop information systems that take a short time to complete. Scrum is a framework within which parties can find solutions to complex problems while being productive and creative creating products of the greatest possible value. Next, there is the Waterfall method, which is to complete one step and then proceed to the next step. Each phase builds on the previous content, is self-contained, and has its own project plan. One of the most popular methods is the spiral method. Adaptive SDLC approaches the proof through iterative and spiral methods; The project goes through four iterative phases in a "spiral" until it is complete, allowing for multiple iterations [4]. And finally Extreme Programming is one of the many software engineering methods and also part of the agile software development methodology [6].

For example, a company developing software using the Scrum and XP methods for UX management uses the SLR method to develop products or services to be more efficient. The results obtained identify several combinations of main approaches that are considered suitable for UX management but cannot identify any approach that is appropriate. handle UX directly [7]. In further research, create a web-based information system which in this application displays some disaster data in Bintan district. In this study, the feature driven development (FDD) method was used to visualize natural disaster data obtained from the Bintan Regency regional disaster management agency, the results showed that the system displays the locations of natural disasters in Bintan Regency as a whole [8]. In designing a sales information system at the Paxjoo online store using the Scrum method, the aim is to create an information system through a sales website (E-Commerce) that is managed both from the transaction and revenue sections. From the conclusions obtained, the website is equipped with Google login features, a web system. using a bootstrap framework, a system built using a payment gateway, gains customer trust and this system is able to load product information, stock and transaction data collection [9].

Research [10] using the literature study method aims to determine the use of the Scrum method in software development and to look for steps in dealing with Scrum usage problems regarding complex processes. The results show that Scrum can be used as needed to help in solving problems in software development. In dealing with complex process problems in Scrum, it is possible to identify the causes of the problem and then the development team discusses solutions to find solutions to existing problems.

Another study [11] conducted a method analysis of the Agile method in developing a website-based information system using journals according to the 2021 topic. The method used is SLR. The result is that the Agile method that is widely used in the development of website-based information systems is Scrum with the focus of the applied field being the business sector.

Based on this background, this research focuses on applying the best method of several types of existing methods and knowing the performance of software development methods, using the systematic literature review (SLR) is expected to be able to produce or determine the type of good method and its performance to be used in software development.

2. RESEARCH METHOD

This study used the systematic literature review (SLR) method or systematic literature review. Literature review aims to obtain a theoretical basis that can support solving the problem being investigated. The stages of the SLR method are as follows.

2.1. Research Question

Research Question (RQ) as a reference in planning the process of searching and extracting from the literature references obtained. The Research Question in this study is as follows.

RQ1: What methods are often used in software development?
RQ2: How is the performance of the methods used in software development?

2.2. Literature Research

Literature search process is carried out to obtain data sources in the form of relevant research that is used to obtain answers to research questions and related references. The literature search process was carried out using the Publish or Perish software and the publication databases used were Springer and Elsevier. The search keyword used is "software development lifecycle". Journal publication years from 2021 to 2022. The number of journals obtained based on searches totaled 166 journals with the following details.

Table 1. Literature Search Results

Database	Number of files
Springer	128
Elsevier	28
Total	166

2.3. Literature Selection

Literature data collected is then subjected to a screening process for accuracy literature which corresponds to using inclusion and exclusion [12]. The inclusion and exclusion criteria in this study are as follows. Inclusion criteria:

- The topic discussion regarding software development methods
- Journal comes from Springer and Elsevier
- Journal published between 2021 and 2022
- Journal has been cited more than 2
- Journal is not a literature review

Exclusion criteria:

- The topic discussion is not about software development methods
- Journal are not from Springer and Elsevier
- Journal cannot be accessed and downloaded
- Journals are not cited more than 2
- Literature review journal

From filtering the literature based on the inclusion and exclusion criteria above, 13 journals were obtained with details in table 2 below.

Table 2. Literature selection results

Database	Number of files
Springer	6
Elsevier	7
Total	13

2.4. Quality Assessment

The data found is then assessed based on the following quality assessment criteria questions:
QA1: Does the journal paper explain the software development method used?
QA2: does the journal paper describe the performance of the methods used in software development?

2.5. Data Collection

Data collection in this study used secondary data in the form of journals obtained from the Springer and Elsevier databases with years of publication between 2021 and 2022. The literature study in this study was carried out using the SLR method.

2.6. Data Analysis

The data collected and grouped are then analyzed to show the following research questions:

a. Methods often used in software development (leads to RQ1)
b. Performance of methods used in software development (leads to RQ2)

3. RESULTS AND DISCUSSION

In this study, data were analyzed based on quality assessment. Table 3 shows the results of the quality assessment (QA1) used to present the data that can be used in this study.

Table 3. Grouping of journals based on QA 1

Method	Reference	Total
Agile	[13], [14], [15], [16], [17], [18], [19], [20], [21]	9
Scrum	[22]	1
Waterfall	[23], [24], [25]	3

It can be seen in table 3 that the Agile method is a popular method used. Of the 13 samples that have been obtained and selected, a total of 9 scientific articles use the Agile method in developing software, besides that there is 1 article using the Scrum method and 3 scientific articles using Waterfall to develop the software. After the process search, it can be concluded that the SDLC method is divided into three, namely Agile, Waterfall and Scrum.

3.1. Agile

Agile method is a software development methodology that emphasizes product delivery in stages and continuously, prioritizing customer needs and satisfaction.

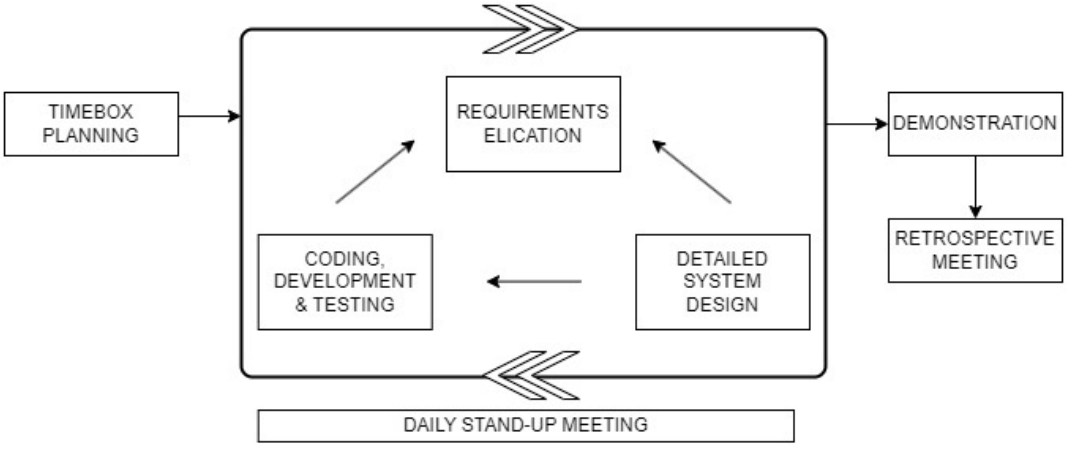

Figure 1. Agile Method

In figure 1 there are several steps of Agile method with the following description:

1. Timebox Planning
   Timebox planning is an Agile technique that entails allocating work inside discrete time blocks, referred to as "sprints" or "iterations" in most cases. Teams commit to performing tasks within the allotted time after identifying tasks that can be finished in that time. Project management, increased transparency, and quicker change-absorption are all benefits of timebox planning.
2. Requirements Elicitation
   The next step is an iterative activity that includes software development system requirements and design. Gathering, assessing, and comprehending user and stakeholder demands is the process of requirements elicitation. During the whole development cycle, this stage is

continuing in Agile. Teams make an effort to comprehend customer requirements more thoroughly and to be flexible in the event of changes.

3. Detailed System Design
   The team designs a more intricate system after gathering needs. The design of the user interface, architectural planning, and other technical requirements are included. In order to account for future changes throughout development, the design must be adaptable.
4. Coding, Development and Testing
   At this point, the group begins to put the software's defined design into practice. Testing is usually done after coding development to make sure the software is working properly. Concurrent testing and development take place, and any problems are fixed right away.
5. Demonstration
   The team performs demonstrations for stakeholders or consumers after developing a certain feature or function. This is a chance to get immediate feedback, check that the program lives up to expectations, and make any necessary alterations.
6. Retrospective Meeting
   The final step is implementation of system methods after user approval. Well-translated user insights by developers can make it easier to deploy new systems.

There are several advantages and disadvantages of using Agile methods, including:

Table 4. Advantages and disadvantages of Agile methods

Deficiencies	Profit
• Reliance on an effective team • Not suitable for large and complex projects • Requires good communication • Expensive cost • There is no guarantee that the product will be produced as needed	• Reliance on an effective team • Not suitable for large and complex projects • Requires good communication • Expensive cost • There is no guarantee that the product will be produced as needed

3.2. Waterfall

Waterfall method is one of the earliest and most well-known software development methods. This method describes the phases of software development in a linear and sequential manner, with each phase only starting after the previous phase has been completed.

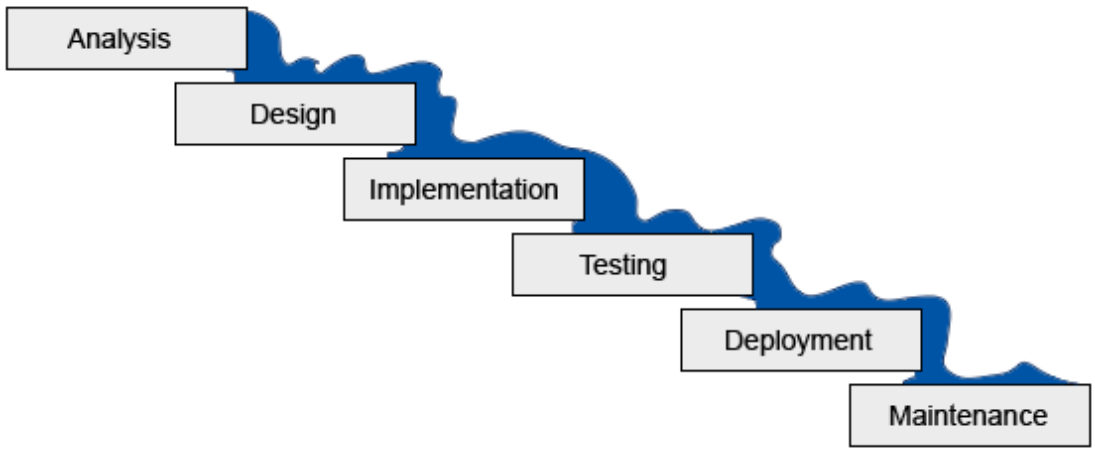

Figure 2. Waterfall method

In figure 2 there are several steps of Waterfall method with the following description:

1. Analysis
   In the first step of the Waterfall SDLC, known as analysis, the software development team works with stakeholders to identify and comprehend the functional and business requirements of the product that will be created. This stage's major objective is to thoroughly outline all the project's requirements and objectives.
2. Design
   Following completion of the analysis, the team begins the design phase. This stage involves the software's architectural design, which covers technical elements including the database, user interface, and workflow. A carefully thought-out conceptual software design is the result of the design phase.
3. Implementation
   Using the previously generated design as a guide, the team starts to code or construct the software during the implementation phase. The creation of program code follows the established plans and standards.
4. Testing
   The software is thoroughly tested after development is finished to make sure that every component works as it should. Unit testing, integration testing, system testing, and stakeholder acceptance testing are all types of testing. Before the software is extensively used, the main goal is to find and fix any faults or problems.
5. Deployment
   The software is prepared for usage in production during the deployment phase. In the production environment, the properly tested and certified software is put into use. To guarantee a successful launch, the transition from the development environment to the production environment is carefully managed.
6. Maintenance
   Usually, the maintenance phase starts after the program has been deployed. This entails keeping an eye on the program and updating it as necessary. Bug patches, new additions, and changes to accommodate shifting user requirements are all examples of maintenance.

There are several advantages and disadvantages of using Agile methods, including:

Table 5. Advantages and disadvantages of Waterfall methods

Deficiencies	Profit
• Less flexible and adaptive • Higher risk of error • Not suitable for large projects	• Detailed and clear documentation • Structured process • Low cost • Ability to produce high quality products

3.3. Scrum

Scrum method is an organized and iterative project management framework that takes an Agile approach. Projects are divided into short cycles called sprints, which typically last one to four weeks and start with planning, work, and a retrospective.

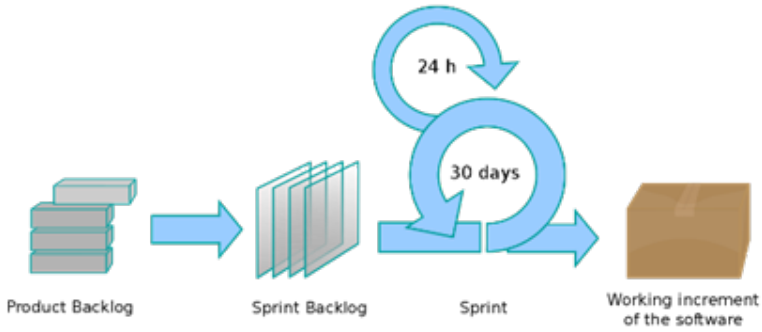

Figure 3. Scrum method

In figure 3 there are several steps of Scrum method with the following description:

1. Product Backlog
   The Product Backlog is a prioritized list of project features and requirements by the Scrum team. The list of features, functions, enhancements, and activities that need to be completed for software development is called the product backlog, and it is prioritized. It's a document that the Product Owner manages that lists the criteria for the product. The most significant items are often included at the top of the product backlog, which is normally organized by business priority. The addition, alteration, or removal of items from the product backlog might alter it over time.
2. Sprint Backlog
   The Scrum Team selects and plans the features to be used in the next sprint. The sprint backlog is a subset of the product backlog selected to be worked on during a specific sprint. A sprint is a time-boxed period, usually lasting 2-4 weeks, during which the Scrum team commits to completing a set of items from the product backlog. The sprint backlog contains tasks that have been defined in more detail and estimated by the development team during the sprint planning meeting.
3. Sprint
   A sprint is a time-boxed development period in Scrum, typically lasting between 2 to 4 weeks. During a sprint, the development team focuses on producing a "working increment" or "working increment of the software," which is software that is potentially shippable and usable. The team commits to completing the items in the sprint backlog during the sprint, and during this period, they do not allow significant changes to those items.
4. Daily Scrum
   The Daily Scrum is a short, time-boxed meeting held by the Scrum team every day during a sprint. Its primary purpose is to provide a daily opportunity for team members to synchronize their work and plan for the next 24 hours.
5. Sprint Review (Working Increment)
   The Sprint Review is held at the end of each sprint to demonstrate the working increment of the software to stakeholders, including product owners, users, and other relevant parties. he team showcases the features and functionality completed during the sprint. Stakeholders can see tangible progress. Stakeholders provide feedback on the increment. They can ask questions, suggest changes, or express concerns. Based on the feedback and insights gathered during the Sprint Review, the product backlog may be adjusted, and priorities may change for the upcoming sprint.
6. Sprint Retrospective

Internal evaluations are carried out by the Scrum team to find strengths, weaknesses, and improvements that can be made in the next sprint.

There are several advantages and disadvantages of using Scrum methods, including:

Table 6. Advantages and disadvantages of Scrum methods

Deficiencies	Profit
• Stable project limitations • Reliance of effective communication • Not suitable for large projects • Requires full involvement of the team	• Flexibility • Strong team collaboration • Transparency • Quality improvement

Results of journal analysis by conducting quality assessment based on quality assessment 2 (QA2). These results are explained in table 7 below.

Table 7. Grouping of journals based on QA 2

Method	Performance
Agile	Agile frameworks are more flexible and suitable for teamwork. The focus is on being flexible and responsive to changes throughout the project. Agile methods involve iterative and incremental development. Teams work in short cycles called sprints. Where each sprint generates pieces of work ready for testing and review. Agile makes it flexible and responsive to changes that occur in project requirements
Scrum	Projects in Scrum are divided into smaller iterations and sprints, and each sprint lasts a fixed amount of time, usually between one and four weeks. A Scrum Team is a smaller group that has a Scrum Master and a Product Owner. The product backlog is used by Scrum to manage and organize project requirements. The Scrum Team meets regularly in short daily meetings called stand-ups to discuss work progress and spot obstacles.
Waterfall	Waterfall method is a sequential and linear project management approach. The process consists of steps that are dependent on each other and must be completed sequentially. Before proceeding to the next stage, each stage must be completed. Requirements analysis, design, development, testing and implementation are common steps in Waterfall. Waterfall is a good choice for projects with clear, immutable requirements.

Table 7 shows that the Agile technique is a flexible approach that is appropriate for teamwork. Like the Agile approach, the Scrum approach is particularly adaptable to changes that are welcomed at any point during the software development process. Because it is carried out progressively, the Waterfall technique provides the benefit of a consistent process structure.

4. CONCLUSION

According to a literature review on software development methods (SDLC), there is no one-size-fits-all SDLC method. Each method has advantages and disadvantages that need to be considered in the context of the project being undertaken. The Waterfall method offers a clear plan and structure that is suitable for projects with clear, consistent requirements. In contrast, Agile and Scrum methods are very flexible in dealing with changing needs, that is what makes Agile methods often used in software development.

In addition, this literature review emphasizes how important it is to properly understand the features and characteristics of each SDLC method, so that organizations can select and implement the method that best suits their projects. In addition, it is important to involve all relevant

stakeholders in the process of selecting and implementing SDLC methods to ensure that their needs and expectations are met.

Adaptability and flexibility are critical in software development in an ever-changing era, where requirements and technology can change rapidly. Therefore, organizations should consider implementing SDLC methods that support Agile or Scrum approaches. This method allows teams to adapt quickly to changes and increase efficiency and effectiveness in software development to meet evolving business needs.

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