

# The Key Factors of Evaluating Agile Approaches: A Systematic Literature Review

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**Abstract**— Currently, Agile Methods (AMs) are extensively being used in projects of various sizes and in different environments, thus surpassing their primary intended scope. For instance, they have been executed in distributed and non-distributed projects. In addition, AMs have been implemented in different project fields, such as engineering, medicine, banking, and manufacturing. Consequently, different Agile approaches have been proposed and integrated with other approaches in order to support the increased demand for diverse project environments. In this direction, various authors have examined the process of developing those approaches; however, the focus on explaining evaluation phases is scarce and scattered. Therefore, this study aims to review pertinent literature to identify the key factors and methodologies used to evaluate the proposed approaches in the Agile domain. The systematic literature review (SLR) methodology was adopted to identify, evaluate, and interpret all existing studies relevant to the research objective. SLR provides in-depth and more thorough results than an ordinary literature review. Forty-eight studies were selected and analyzed. The results show that applicability, effectiveness, and efficiency are the three most frequently examined evaluation factors, whereas case studies and surveys are the most frequently used research methods in evaluation studies. Factors identified in this review provide the evidence and the opportunity to design instruments or assessment forms that meet the needs of those researchers who are planning to evaluate their proposed Agile approaches.

**Keywords**— Agile method, evaluation factors, evaluation methodologies, Systematic literature review (SLR)

## 1. Introduction

Agile methods (AMs) are family of lightweight methods used to develop software projects, and are increasingly gaining wide recognition within software development organizations (SDOs). These methods were first initiated in February 2001 by experienced practitioners of organizational anarchists, and they operate under four core values

and twelve principles, which are called Agile Manifesto [1].

Hence, AMs have distinguished properties in which created a paradigm shift in the field of software engineering (SE) during the past two decades. Instead of fixed scope deliveries, budgets, and schedules, it therefore places more value on people, interaction, and working software rather than on tools, contracts, and plans [2]. Moreover, these methods provide a shorter cycle for the development process with higher customer satisfaction, while also offering rapid changes to the business requirements in the software development environments [3].

In spite of that the knowledge on implementing AMs in SDOs is very scarce [4], these methods are being extensively used in projects of different sizes and various environments, thus exceeding their primary intended scope. For instance, they have been executed in a variety of project sizes, along with both distributed and non-distributed projects. Furthermore, AMs have been implemented in different project fields, such as engineering, medicine, banking, and manufacturing.

Even though the implementation process is complex [5], different Agile approaches have been accordingly proposed, developed, enhanced, and integrated with other approaches [3], [6]. Silva, Schramm and Damasceno [7] confirmed that evaluation of these approaches is an essential task in software development projects. In this study, the term “approach” refers to any proposed model, method, methodology, framework, or technique in the Agile domain.

Various studies have shed light on how to propose and improve the Agile approaches that can support the increased demand for diverse project environments. However, authors of these studies did not describe the factors and methodologies used in

the evaluation process. Thus, there is a need for exploring how proposed approaches are being evaluated by reviewing the existing factors. Therefore, the main aim of this study is to identify the key factors used to evaluate the proposed Agile approaches. For this purpose, we performed a systematic literature review (SLR) following the guidelines proposed by Kitchenham, Budgen and Brereton [8]. An SLR is a well-defined methodology used for identifying, evaluating, and interpreting all available pertinent studies to answer specific research questions.

The remainder of this paper is organized as follows. In Section 2, the related works are reviewed and the previous studies are compared with the current study. Next, the research methodology employed in this study is described in detail in Section 3. In Section 4, the results obtained by conducting the SLR are discussed and analyzed. Finally, Section 5 concludes the paper by providing some suggestions for future works.

## 2. Related Work

This section briefly presents the related studies in which the authors aimed to identify the factors influencing the AMs. A literature survey and review was developed by Shahane, Jamsandekar and Shahane [9] to outline the factors influencing the AMs in practice. The scenarios and case studies across the globe were identified with the prime objective to find their relevance and significance in Indian SDOs. Cerdeiral and Santos [10] presented a mapping review to identify various methods, techniques, and tools that can assist in high-maturity software project management (SPM). Nevertheless, this mapping study focused on the maturity aspect of SPM. As such, a tertiary study was conducted by Hoda, Salleh, Grundy and Tee [11] to provide an overview of the SLRs on Agile research topics for SE researchers and practitioners. Although a variety of Agile aspects were discussed, the aspect of Agile evaluation was not covered.

Campanelli and Parreiras [12] conducted an SLR to identify the method tailoring approaches adopted and the criteria used for Agile practice selection. Though, the aim of this SLR was not to identify factors or methodologies used in the evaluation process. Another SLR conducted by Abrantes and Travassos [13] set out to identify the software practices usually used in the context of Agile

approaches for software development. This SLR not only focused on Agile practices, but some relevant studies were not included because of the restricted criteria used in the search string. In addition, Kupiainen, Mäntylä and Itkonen [14] study aimed to describe the reasons for and the effects of metrics used by Agile teams in the industrial development context. Nonetheless, the search was performed in three databases only, and the authors did not evaluate any Agile approaches.

Moreover, Senapathi and Srinivasan [15] study was limited to identify the critical factors that impact sustained usage of Agile methods. The SLR conducted by Satria, Sensuse and Noprisson [16] focused on the literature on improving Agile methods, in which all of its aspects, such as time, documentation, and usability were described. Although the former study is quite similar to the present investigation, it did not examine and explore the evaluation factors used in Agile domain. Furthermore, the authors acknowledged that their results were insufficient and non-comprehensive due to using limited keywords and searching in few databases.

Overall, previous studies focused on specific aspects, such as sustained using of and improving Agile methods, along with the related practices and metrics used in software and industrial development. However, authors of these studies did not describe the factors or the methodologies used in the evaluation process of these proposed or existing Agile approaches. Therefore, our investigation responds to the need for expanding the search databases to gain a comprehensive understanding of how the proposed and developed Agile approaches are being evaluated by adopting different methodologies with the use of suitable factors. Table 1 summarizes the relevant SLR studies compared with the current study.

From Table 1, it is noticeable that current study has different features compared with the previous studies. For instance, the objective of the current study is completely different from the objectives of the other studies, whereby no SLR study has been conducted with the same focus. In addition, we searched eight libraries to cover a larger scope of sources. As such, this literature review includes a large number (48) of studies although the search process is limited to the previous ten years.

**Table 1.** Comparison of previous SLR's with current study

Source	Period	Used Database	Included Studies	Study Objective
[13]	1998 - 2010	7	24	To identify the software practices usually used in the context of Agile approaches for the software development
[14]	2000 - 2013	3	30	To describe the reasons for and effects of metrics used by Agile teams in industrial development
[15]	2005 - 2012	5	18	To gain a comprehensive understanding of the various factors which impact the sustained usage of Agile methods
[16]	2005 - 2017	3	15	To gather literature that focused in improving Agile methodologies
This study	2008 - 2018	8	48	To identify the factors and methodologies used for evaluating Agile approaches

### 3. Methodology

An SLR methodology was adopted in this study in order to find previous researches on the evaluation factors of proposed Agile approaches. It is specified and efficient methodology of distinguishing, evaluating, and analyzing published papers to explore a particular research question. In addition, the SLR is a trustworthy methodology and recently has got popularity in SE domain. In this study, we followed the guidelines provided by Kitchenham, Budgen and Brereton [8].

### 3.1 Research questions

The main objective of this study is to review the factors and methodologies used to evaluate the proposed Agile approaches. The research questions (RQs) for this review are:

- **RQ1:** What are the factors used to evaluate the Agile approaches?
- **RQ2:** How Agile approaches are being evaluated?
- **RQ3:** What are the Agile methodologies implemented in the included studies?

### 3.2 Search string

In order to formulate the search string, the key criteria provided by Kitchenham, Pretorius, Budgen, Brereton, Turner, Niazi and Linkman [17] were employed. Besides that, the asterisk symbol '\*' was used to expand the research scope and retrieve all possible suffix variations of the search terms. For example, the Evaluat\* term involves other terms such as Evaluate, Evaluating, and Evaluation. Accordingly, the researchers formulated the search string for this study that is shown below:

("Agile Method" OR "Agile Process") AND  
("Evaluat\*" OR "Validat\*" OR "Assess" OR  
"Measur\*") AND ("Factor" OR "Dimension" OR  
"Criteri\*" OR "Metric")

The search string covers three main concepts that represent the study objective. The first concept was designed to retrieve studies focused on the Agile domain, while the second concept was directed to retrieve any evaluation study. The third concept was constructed to represent the factors and its similar terms.

### 3.3 Search resources

This study was limited to review the articles published in the previous ten years (2008-2018). It was focused on searching in scientific databases instead of books or technical reports, as it assumes that the major research results in books and reports are also usually published in scientific papers. The use of ACM and IEEE along with other two indexing databases are sufficient to search evidences in SLRs within SE domain [18]. However, in this study, eight electronic databases were utilized as the data sources, which are ACM Digital Library, IEEE

Xplore, Science Direct, Springer Link, Emerald Insight, Scopus, ISI Web of Science, and Google Scholar. These data sources were chosen due to its popularity as well as relevance to study scope.

ACM Digital Library was included as it is the world’s largest database for computer science, while IEEE is the significant innovative association for excellence in the field of technology. Science Direct was involved due to its world coverage for online collections of published scientific research. Springer Link was selected because it coordinates with the academicians and authors in the scientific community. Emerald Insight database was included as the source of scientific literature, whereby it contains articles, research papers, chapter items, other scientific disciples in various fields including information systems and technology. Moreover, Scopus is considered the most extensive citation and abstract databases, while ISI Web of Science that has a higher impact. As previous literature review studies, Google Scholar was also included to cover a larger breadth of sources that could add additional perspectives, whereby it is a broad database that has across interdisciplinary academic indexed on the internet.

**3.4 Inclusion and exclusion criteria**

Table 2 lists the inclusion and exclusion criteria used to identify which studies are related to the study and questions.

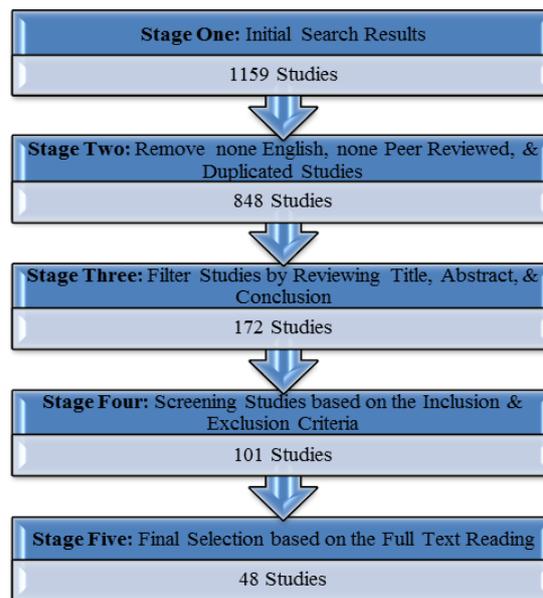
**Table 2.** Inclusion and exclusion criteria

<b>Inclusion Criteria</b>	<ul style="list-style-type: none"> <li>- Studies that describe any evaluation factors or methodologies used in evaluating Agile approaches</li> <li>- Studies that address how the Agile approaches are being evaluated</li> <li>- Studies that report empirical results</li> </ul>
<b>Exclusion Criteria</b>	<ul style="list-style-type: none"> <li>- Studies which are not relevant to the research questions</li> <li>- Studies that do not focus on Agile software development context</li> <li>- Studies which are not related to evaluating Agile approaches</li> <li>- Studies which are not primary</li> <li>- Studies which are not complete or unavailable</li> </ul>

Firstly, the extracted studies were tested and then excluded if such study met any one of the exclusion criteria. The rest of studies were considered in case of such study met only one of inclusion criteria.

**3.5 Studies selection**

Using automatic search, the search string was used across the pre-identified eight databases to retrieve publications of initial search. A total of 1159 studies were initially retrieved in the stage one. Then, in the second stage, the initial results were reduced to 848 after removing the none English, none peer-reviewed, and duplicated studies. In addition, 676 studies were excluded based on reviewing its title, abstract, and keywords sections, and thus 172 studies were considered as primary studies. In the stage four, another 71 studies were excluded based on screening the primary studies against the inclusion and exclusion criteria. Based on the full text reading, only 48 out of 101 studies were included for the final selection. Figure 1 summerizes the stages of studies selection.



**Figure 1:** The stages of studies selection

**3.6 Data extraction and synthesis**

In this activity, data were extracted and synthesized from final selected studies to identify and record specific information that contributes to this study and answers the research questions. Within this activity, quantitative analysis and descriptive statistic visualizations were used to explore and summarize the studies.

### 4. Results and Discussion

This section presents the SLR results based on 48 studies (listed in Appendix A). An overview of the results and answers to the three research questions are presented below.

#### 4.1 Studies overview

Figure 2 depicts the distribution of studies published within the 2008–2018 period. As can be seen, most of the included studies were published in 2016, while no study from the year 2011 is included.

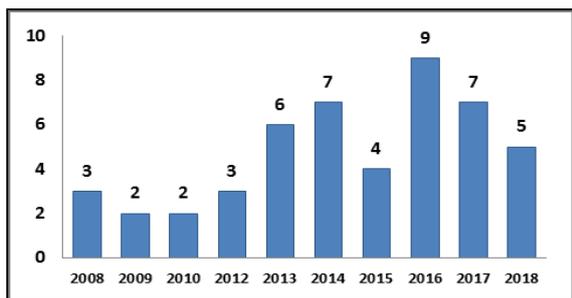


Figure 2. Studies distribution through years

Figure 3 shows the distribution of published studies on the digital libraries.

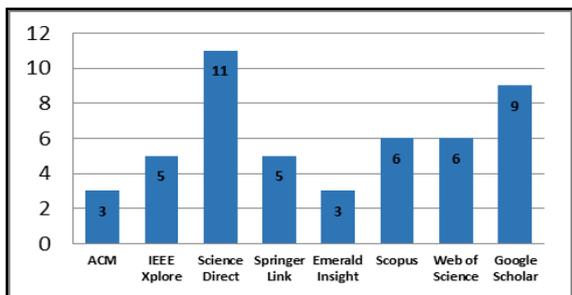


Figure 3. Studies distribution on digital libraries

Figure 4 depicts the percentage of published studies per each library. It is noticeable that majority of the selected studies were retrieved from Science Direct.

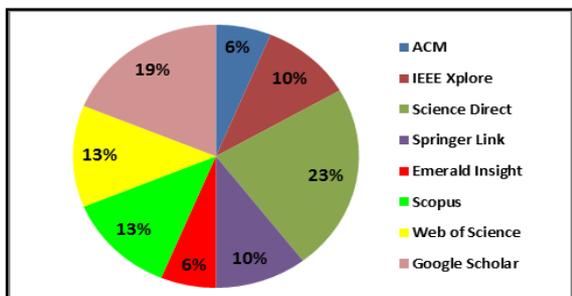


Figure 4. Studies distribution on digital libraries

All selected studies are peer-reviewed, as 27 studies (56%) were published in journals, while 21

(44%) were published in conference proceedings as shown in Figure 5.

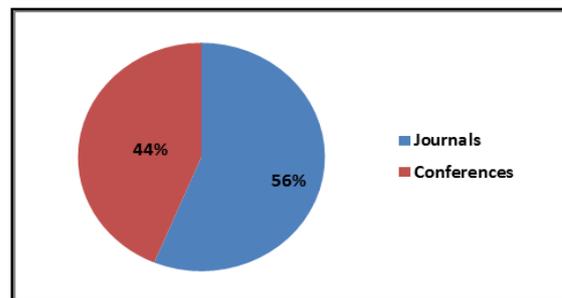


Figure 5. Types of studies

Table 3 presents the studies by publication channel. The Journal of Systems and Software had the largest number of studies (7 studies). The journals Information and Software Technology and International Journal of Project Management had respectively three and two studies. Two studies each were presented at Agile Conference, IEEE Conference, and International Conference on Software Engineering and Knowledge. The remaining studies were retrieved from different channels.

Table 3. Studies distribution through publication channels

Publication Channels	N	%
Journal of Systems and Software	7	15%
Information and Software Technology	3	6%
International Journal of Project Management	2	4%
Agile Conference	2	4%
IEEE Conference	2	4%
International Conference on Software Engineering and Knowledge	2	4%
Remaining studies from different channels	32	63%
Total Studies	48	100%

#### 4.2 What are the factors used to evaluate the Agile approaches? (RQ1)

Results revealed that 32 factors have been used in evaluating proposed Agile approaches, whereby the quality factor has the greatest number of occurrences in the selected studies. However, the quality is not only an evaluation factor, as it is a general concept and a wide dimension, which possesses set of factors and sub-factors as well. For instance, the quality of SE process is measured based on four main factors: suitability, usability, manageability, and evolvability. Meanwhile, the usability factor is measured by other subfactors, such as accessibility, understandability, learnability, and adaptability [S9]. Nevertheless, the usability commonly measures the consistency and standardization, the ease of use and learnability, the layout and organization, flexibility and visibility, as well as clarity [S24], [S35], [S39]. Therefore, herein we only discuss the most frequently used three factors, coming after the quality factor, in evaluating the proposed approaches.

Specifically, the first vital factor is to prove the applicability of the proposed approach, i.e., to determine whether it can be practically implemented in the real environment or not. To do so, a prototype tool is designed just to prove the concept of the proposed approach, which is subsequently implemented by software practitioners. Ultimately, factors, such as gain satisfaction, interface satisfaction, task support satisfaction, perceived usefulness, and perceived ease of use, are adopted to validate the model applicability. The applicability factor has been validated in 13 studies [S2], [S7], [S8], [S9], [S17], [S20], [S27], [S29], [S35], [S39], [S40], [S47], [S48].

The second factor is to ensure the effectiveness of the included components and criteria within an approach. This factor is commonly used in the verification process of the development stage. The proposed approaches need to verify its understandability, relevance, feasibility, organization, and comprehensiveness through knowledge and domain experts [S29]. The effectiveness factor has been used in 11 studies [S1], [S3], [S4], [S9], [S18], [S20], [S35], [S38], [S41], [S46], [S48]. The third factor is to measure the efficiency of the proposed approach based on its capability to produce required and reliable results

within the allocated time and budget. The efficiency factor has been measured in eight studies [S9], [S10], [S14], [S20], [S27], [S28], [S35], [S41].

#### 4.3 How Agile approaches are being evaluated? (RQ2)

Table 4 summarizes the methods and techniques used to evaluate the proposed Agile approaches.

**Table 3.** Studies distribution through publication channels

Publication Channels	Source	N
Case Study	[S2]–[S4], [S12], [S17], [S19], [S21], [S23]–[S26], [S28], [S29], [S38], [S43], [S44], [S48]	17
Survey	[S1], [S8], [S10], [S11], [S13]–[S16], [S20], [S33], [S34], [S40], [S42], [S44]–[S46]	16
Interview	[S4], [S8], [S9], [S16], [S18], [S19], [S23]–[S25], [S36], [S48]	11
Focus Group	[S11], [S18], [S19], [S29], [S41], [S47]	6
Expert Review	[S19], [S22], [S27], [S30], [S31], [S33]	6
Simulation	[S31], [S32]	2
Observations & Workshops	[S8]	1
Multi Criterion Decision Making	[S35]	1
Description & comparison	[S37]	1
Experiment	[S39]	1
Not Identified	[S5]–[S7]	3

It is clear that case studies and surveys are the most frequently adopted research methods for evaluating proposed Agile approaches, as they represent 26% and 25% respectively of all studies. Following that, interviews (17%), expert reviews (9%), and focus groups (9%) are employed. However, focus group method has recently gained

popularity within the evaluation studies in the SE domain to obtain feedback on proposed approaches or designed prototypes, as stated by Bräuer, Plösch, Saft and Körner [19]. Figure 6 shows the distribution of evaluation methods and techniques used in the retrieved studies.

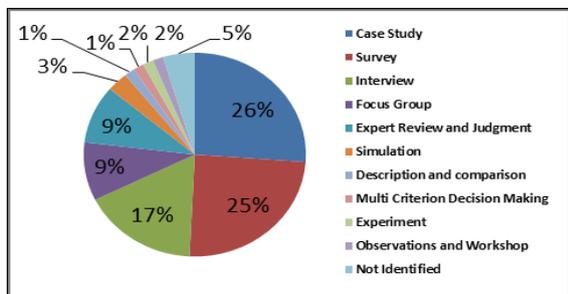


Figure 6. Used evaluation methods

#### 4.4 What are the Agile methodologies implemented in the included studies? (RQ3)

Overall, in 27 studies (56%), general Agile methods were used, but their authors did not define a specific methodology. Specific methodologies were adopted in 36% cases, while in the remaining 8% of the studies' methodology was not defined. Figure 7 depicts the distribution of used Agile methodologies within the included studies.

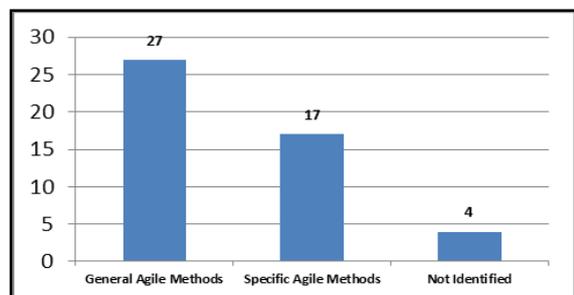


Figure 7. Distribution of used methodologies

The most frequently used Agile methodologies were Extreme Programming (XP) and Scrum, whereby XP method was used in 13 studies [S3], [S5]–[S7], [S16], [S28], [S30], [S34], [S35], [S42], [S44], [S46], [S48], and Scrum method was also used in 13 studies [S3], [S5], [S6], [S8], [S16], [S22], [S23], [S26], [S28], [S30], [S32], [S34], [S42]. Authors of seven studies [S5], [S16], [S28], [S30], [S34], [S4]2, [S46] adopted Feature Driven Development (FDD), while in five studies [S3], [S16], [S30], [S34], [S35] Rational Unified Process (RUP) was adopted. Despite of the increased adoption and the growing popularity of Kanban

method in SDOs [20], the study results show that this method was utilized in only five studies [S16], [S18], [S21], [S22], [S29]. Besides, Crystal Clear Methodology (CCM) was used in four studies [S5, S6, S28, S34], whilst Dynamic Software Driven Method (DSDM) was used in three studies [S6], [S28], [S35]. Authors of two studies [S5], [S16] implemented the Adaptive Software Development (ASD), while two studies [S16], [S27] were based on Lean, and Test-Driven Development (TDD) was used in only one study [S34]. Figure 8 shows the distribution of implemented Agile methodologies.

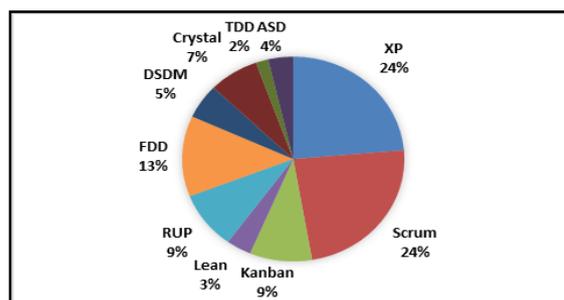


Figure 8. Distribution of implemented Agile methodologies

### 5. Conclusion and Future Work

This work is an SLR focusing on literature related to the key factors and methodologies used in evaluating the Agile approaches. A total of 48 studies were analyzed based on three research questions. The results show that applicability, effectiveness, and efficiency are the most frequently used three factors, alongside the quality factor, in evaluating the proposed approaches. On the other hand, case studies and surveys are the most frequently used research methods in evaluation studies, followed by interviews and focus groups. Overall, this study provides evidence needed to design instruments or assessment forms that meet the needs of those researchers who are planning to evaluate their proposed approaches in the Agile domain. In future studies, it would be beneficial to discuss and classify the 32 factors identified in this review. Specifically, in our future investigations, focus will be given to the quality factor as it was ignored in this study. Still, as it is a general concept and a wide dimension, it needs further exploration. Moreover, the success factors influencing the Agile project management could be also reviewed and investigated.

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## Appendix A

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