

A survey of agile development methods and tools in cloud environment

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ABSTRACT

Agile processes such as Scrum and eXtreme Programming (XP) are different from conventional software development life cycles (SDLC) like waterfall and spiral. The iterative development by making use of short development cycles, continuous integration of software versions, frequent feedback, customer involvement, team collaboration and adaptive planning to requirement volatility are the factors that make these processes different and popular. However, the environments where agile processes are executed are traditional (desktop or Intranet based), which require prolonged manual setup time to requirements, design, build, test and deploy a software project causing major delays. The traditional environments are also expensive, face issues related to timely availability and scalability, and hard to react to change (on-demand customization). This brings into account the need of a new end-to-end approach to support agile-based software production supported by major processing power, build, deploy and test capabilities. Based on our investigation, this can take place efficiently by making use of cloud service models such as Software as a Service (SaaS), Infrastructure as a Service (IaaS), and Platform as a Service (PaaS). Thus, this paper attempts to investigate the above-mentioned issues and shares the findings obtained from the existing literature.

Keywords: agile software development; cloud computing; survey; XP; SCRUM; agile tools;

1. INTRODUCTION

Agile processes [1-3] such as Scrum [4] and eXtreme Programming (XP) [5, 6] make use of short development cycles, continuous integration of software versions, frequent feedback, customer involvement [7], team collaboration [8, 9]. On the other hand, use of cloud service models such as Software as a Service (SaaS), Infrastructure as a Service (IaaS), and Platform as a Service (PaaS) is growing fast in the agile development environment [10]. Academically, however, based on our previous survey [11], the findings show there are only a few literature reviews available that cover cohesively on these two cutting edge components of state-of-the-art software research i.e., agile team, agile methods or practices and cloud computing [12, 13]. Figure 1 presents a simple depiction of composition of agile team, methods and cloud services. Based on this Figure 1, a software team first must learn the agile concepts, methods and practices and start practicing agile without cloud-based tools. Once they are comfortable with the idea, methods and practices of agile then they may proceed to adopt cloud services for end-to-end software development and deployment.

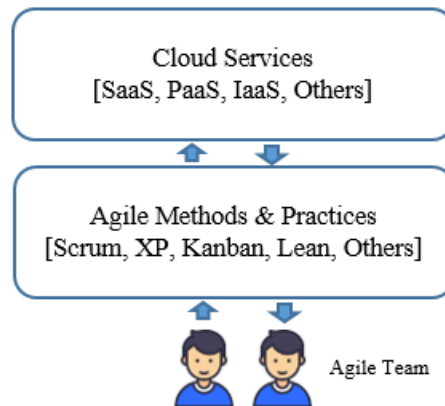


Figure. 1 Interaction model: agile team, agile methods and cloud service

In order to implement the above depicted interaction model, our findings reveal that none of the proposed models is suitable to cover the needs of an end-to-end agile software development, and deployment in cloud environment. This gap has also been revealed in [7, 14]. Besides the gaps in existing approaches, the tools support pose significant difficulties for agile adoption in cloud computing [11, 15]. Though, there are a number of tools available that separately support agile development such as Jira [16], Confluence [17], and Trello. On the other hand, there are some quick development environments like: Nitrous.io [18] and Google App Engine [19]. However, these tools work in an isolated way for agile teams. For instance, the agile teams have to create project management in Jira or AgileBench and then decide which sprint should be built, tested, and deployed using available performance or security cloud service. Then, the build, test and deployment is processed using Nitrous.io [18], Google App Engine [19], for instance. This approach is quite inconvenient practically. One question comes to our mind is: which agile method is more critical to be supported by agile services? In order to find more on this, let us proceed to the next section.

2. MOST POPULAR AGILE METHODS: SCRUM AND XP

According to a couple of surveys conducted by [11, 20, 21] in 2012, 2013 and 2016 respectively, the percentage of agile methods selection and adoption by software development communities and organizations around the world shows that Scrum is still the most popular method among all. Whereas a mix of Scrum and XP practices is the second most popular. Figure 2 from [21] shows that 58% companies/communities use Scrum for their software development.

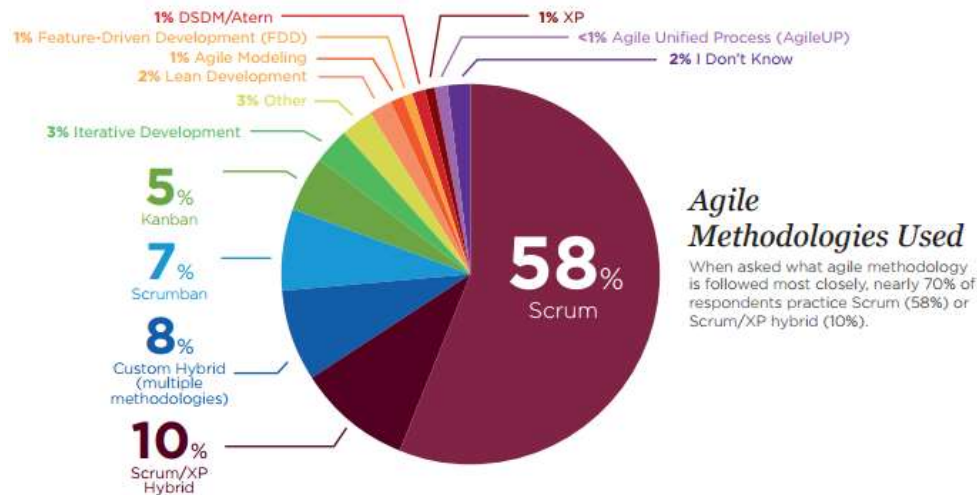


Figure. 2 Most popular agile methods [20]

Though, in spite of the importance of Scrum and XP as noted in the above mentioned studies, the effectiveness of using cloud environment for any other agile development method is also undisputed, but understanding the detailed mechanisms, activities and patterns that support this cohesion is less well-understood [9, 22]. Academically, there is a need to explore the existing studies and find research gaps in both the domains: agile development and cloud environment as shown in intersected area of two circles given in Figure 3.

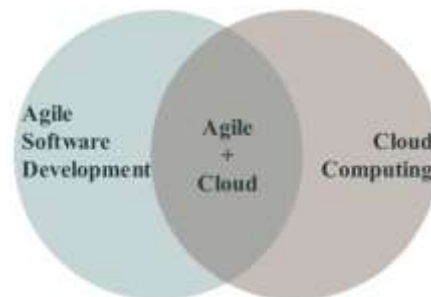


Figure. 3 Domain of agile methods and cloud computing

3. DISCUSSION ON AGILE DEVELOPMENT IN CLOUD ENVIRONMENT

The agile methods depend on the interactive communication between developers and customers. On-premises, it is easy to establish communication and interaction, however, in distributed environment it is difficult. Cloud computing helps by providing different means of communication between user and software team such as file sharing, idea sharing, and discussion forums, wikis, real-time reports and code sharing [23]. Project management tools, code management and testing tools are provided as Software as a Service (SaaS). For project development and deployment different IDEs and platforms are provided through Platform as a service (PaaS) in the cloud computing. Several studies claim that cloud computing helps in agile methods. In addition, Emails [24], Skype chat [12, 25, 26], and video conferencing, cloud telephony by Amazon Web Service (AWS) [27] are also used for communication. After intensive review of existing studies, we have developed the block diagram to show agile development in cloud computing environment as shown in Figure 4.

The block diagram shows that the framework consists of four artefacts to practice agile software development in cloud computing environment. Collection of communication and collaboration tools help for communication among all stakeholders of project. Collection of code repositories help for managing different versions of code belonging to distributed teams. Agile tools help in managing project management activities. Collection of cloud platforms helps in facilitating different hardware and software resources.

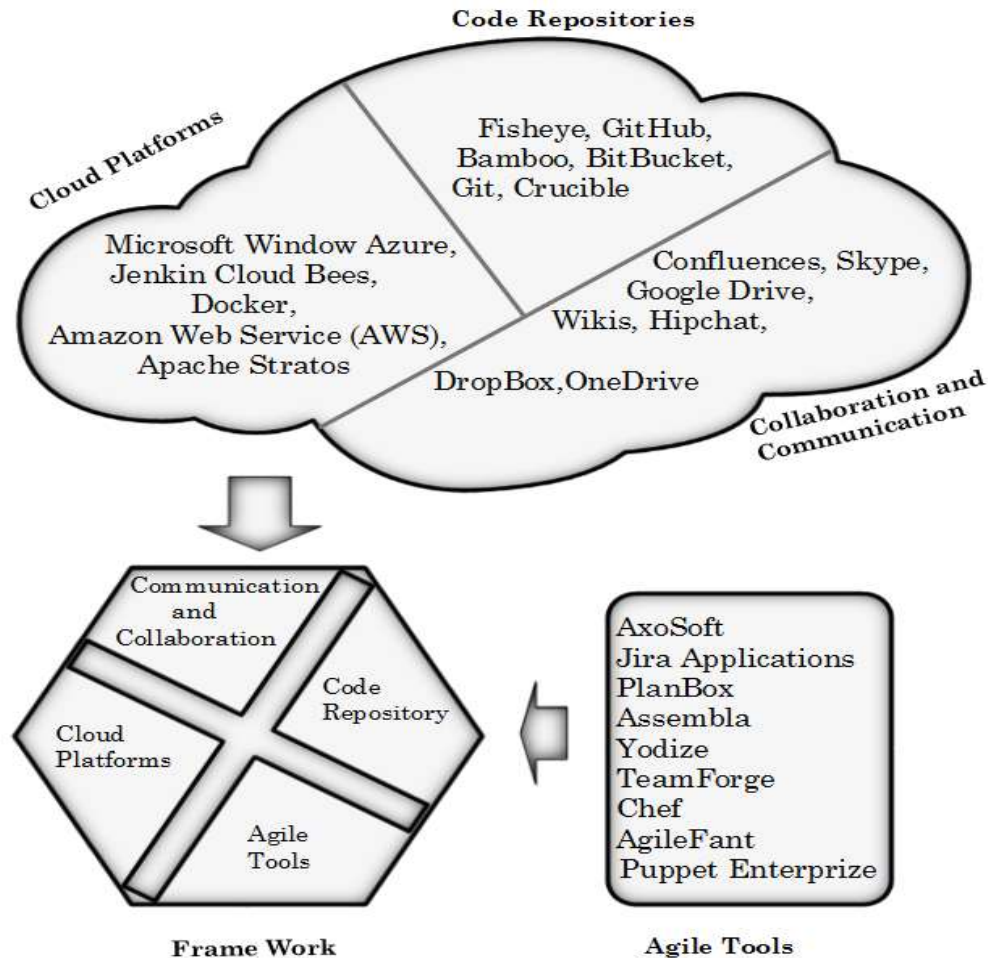


Figure. 4 Artefacts to show agile development in cloud computing

There are only a few researches closely linked to agile development in cloud environment [4, 10, 12, 13, 25, 28-30] as presented in Table 1.

Table. 1 Features and limitations of existing studies

Paper #	Features	Limitations
[4]	<ul style="list-style-type: none"> • More than 15 tools are analyzed • Cloud emphasized tools • Agile emphasized tools 	<ul style="list-style-type: none"> • Mentioned about the need of a new tool • New tool is not introduced
[12]	<ul style="list-style-type: none"> • Mentioned the need of a service to support fast iterative development through ubiquitous access to resources for team members 	<ul style="list-style-type: none"> • New service or model is not introduced
[13]	<ul style="list-style-type: none"> • Briefly discussed about benefits of cloud being an Agile accelerator and enabler of better business outcome 	<ul style="list-style-type: none"> • New service or model is not introduced
[10]	<ul style="list-style-type: none"> • Briefly discussed 4 maturity levels in SaaS architecture 	<ul style="list-style-type: none"> • New service or model is not introduced
[25]	<ul style="list-style-type: none"> • Fig. 4 is the most important Figure that shows comparison of duration of application development when using agile methods without and with cloud computing 	<ul style="list-style-type: none"> • One application was developed but no new sharable service or model is not introduced
[28]	<ul style="list-style-type: none"> • Figure 4. is the most important figure that shows a Cloud Based Agile Application Development Lifecycle 	<ul style="list-style-type: none"> • ACD model is proposed. But a few claims have been made without describing the experiments and results analysis.
[29]	<ul style="list-style-type: none"> • Automated Build, Test, Deployment in the Cloud 	<ul style="list-style-type: none"> • A useful tool proposed: TeamForge by CollabNet
[30]	<ul style="list-style-type: none"> • Investigated the effects of cloud software's agile development in the area of client services in a New Zealand tertiary institution. 	<ul style="list-style-type: none"> • Limited to survey-based feedback gathered for staff development

The research in [25] focuses on Dynamic System Development Method (DSDM) only which is least used agile method based on the results revealed by recent surveys [11, 20, 21]. Authors of [28] proposed a model called Cloud Based Agile Application Development Lifecycle. However, they did not support their findings based on any case study or experiment. For instance, it has been mentioned that with ACD work load is highly utilized and stable and development cycle time is shortened up to 75%. Yet, no experiment or case study has been provided to prove it. Another related survey about agile and cloud tools is conducted in [4]. This survey summarizes the tool support for agile methods.

In this study, authors classify the cloud-based agile tools into two main categories: *agile emphasized tools* and *cloud emphasized tools*. The former category emphasizes more on agile related features like agile project management, agile methods and less emphasize on cloud. The later one emphasizes more on cloud features such as PaaS, IaaS, SaaS, and DevOps but there is less emphasis on agile development.

4. CHALLENGES IN AGILE DEVELOPMENT AND CLOUD COMPUTING ENVIRONMENT

With respect to limitations or hurdles introduced due to inclusion of cloud computing reported by several studies are as follows.

4.1 Overhead of cloud provider

In agile software development, requirement gathering involves customers, users and developers but due to cloud computing environment now cloud provider also included in this activity [31, 32]. Cloud provider will know the size, architectures detail, virtualization strategy and infrastructure usage. Virtualization technique is used to cater many customers parallel. To fulfill the high demand of customer quality of service agreement required. Cost estimation also depends on cloud provider because cloud provider will estimate the cost of infrastructure.

4.2 Communication and coordination among cloud provider and software engineer

It's hard to establish the interaction between a software engineer and cloud provider [31-33]. The amount of interaction depends on the type of cloud. In private cloud, the user has more power of governance and requires less interaction than public cloud. Software engineers feel comfortable with private cloud due to security and liberty, but it is costly.

4.3 Security threat

The study S19 reported that the security is a major concern in cloud computing, the threat can be due to data and code ownership. The enterprises feel uncomfortable in residing their data on public cloud S17. Furthermore, client interfacing groups deal the hosting on the public cloud that causes the security threat for enterprises regarding confident data [33, 34]. The study [35] and [28] addressed the issue of data privacy using private cloud but the scalability is an issue on the private cloud in term of increasing cost.

4.4 Lock-in and interoperability concerns

In cloud computing, the big issue is interoperability, there are no universal standards or interface defined for collaboration among different cloud platforms. Each cloud provider has its own services. It is very difficult to select cloud service. After selecting cloud vendor, change of vendor leads to vendor's lock-in. The studies [28, 31, 36, 37] reported about this issue.

4.5 Overhead of changed environment

The software developer's community feels uncomfortable in a new cloud computing platform without appropriate guidance and understanding for effective use of cloud computing standard architecture [36]. The study [35] reported that extra effort is spent by the team to search the open libraries for developing mobile cloud application. Then an extra effort is needed for modification and integration in existing code.

4.6 Lack of practical experience

In most of the empirical studies, facilitation of cloud computing in agile software development practices are in theory, there is lack of actual practical aspect and challenges [27]. The no-technical problems such as inadequate training and poor leadership are pointed out by industry experts. The study [36] reported that it is difficult to find the enterprise having agile development methodology and cloud environment that can answer the question related to process practices (such as efficiency and productivity).

4.7 Requirement for online connectivity

One challenge of cloud computing is to maintain an environment for different stakeholders of organization [27, 36]. This provision increases the cost of development. In addition, the provision of a platform for development and testing environment also increases cost.

4.8 Development environment safety

During development, the team used tools in public domain which may expose code, built data and configuration files leading to huge risk in terms of security and project confidentiality [27, 35].

4.9 Identity and access management

Web hosting on AWS cloud is in public domain, thus it is a concern among users of hosted web portals. This will allow access to the user of one web portal to the user of some other web portal and hence prone to false identification and unauthorized access [27, 28, 33].

4.10 Compliance to legal standards

In European Union (EU), they practice legal standard regarding security and ownership of organizations data [27, 37]. Public cloud set up is not acceptable there. This is a challenge for global companies.

4.11 Quality concerns

The study [27] reported that in cloud computing environment there is enhancement regarding cost and time however with respect to quality, on- premise software development produce quality software as compared to cloud environment due to security concerns.

Communication and security threat is reported by the majority of the primary studies as a threat in this area. Change environment for software engineers is also a disturbing challenge.

5. CONCLUSION

This paper presents a survey on agile development methods and tools that can be used in a cloud environment for effective and efficient performance. We have surveyed 37 papers in relation to this topic and could only find 18 papers which are closely related to the subject of this paper. Though, there are a few commercial tools available that support agile development in cloud environment such as TeamForge, SourceForge, Jira, Confluence and so on. However, there are not sufficient models, approaches, or techniques to address the challenge of end-to-end management (from user story to software deployment). The traditional (non-cloud) environments are time consuming, expensive, face issues related to timely availability and scalability, and hard to react to change (on-demand customization). Hence, there is a need to propose end-to-end process management approaches for agile-based projects in the cloud environment. Agile software development in cloud computing environment is a growing area of research. Although it has a number of challenges and major contribution in this area is shown by the cloud providers. However, there is a significant number of studies reported the benefits of cloud in agile software development. Cloud computing seems the natural alliance for agile software development. With the advancement in cloud computing, the challenges in this area will be minimized.

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