

OVERVIEW OF ADVANTAGES, CHALLENGES, AND ADAPTATION OF AGILE METHODS IN MOBILE DEVELOPMENT

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ABSTRACT




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Agile development is a suitable method for software development in mobile devices. Agile methods allow software teams to respond quickly to changes. The main difference between desktop development and mobile application development is rapid changes and permanent updates. This research discusses mobile application development by using agile methods. In agile methods, there are significant ways of speeding up the development of mobile app projects. An adaptation of agile approaches for mobile projects is the greatest concern for organizations, which some of these cases have been investigated in the present research. The "ALP-mobile" model has introduced a combination of agile and lean methods to solve the problems of the mobile application development. Also, "ALP-mobile" overlay the project lifecycle in the mobile application development. High quality development and test mobile applications are one of the challenges in mobile applications. The present research deals with the usual challenges in developing and testing mobile applications in agile environments.

Keywords: mobile software development; Agile Methodologies; ALP-mobile; mobile application; agile environment;

1. INTRODUCTION

Large companies such as Philips, Nokia, British Telecom, etc. are already adopting or planning to adopt agile software the method as their tool against software related challenges [1]. Research indicates that there are special challenges for mobile application development, such as usability and user interaction design, selection of the implementation technology for mobile app execution, issues of development processes, tools, user interface design, issues of quality, etc. [2]. To provide a solution to these challenges, agile development is a suitable method for software development in mobile devices. Research indicates that agile methodologies are one of the best methods for mobile software development processes [3]. To overcome the challenges of mobile application development some of the researchers merged the concepts of Scrum, XP, and Kanban together [4]. Agile methodologies are Compatible with mobile development projects and steps are done in the short times, and this method require flexibility and reduce wastage and time in projects [3]. In mobile application development usually, agile approaches are used to requirements engineering in projects [5].

2. AGILE METHOD, A SOLUTION FOR MOBILE SOFTWARE DEVELOPMENT

Research shows that agile methods have a good level and suitability for the development of mobile applications [6]. There are several main factors effective in agility. It includes operating culture, team size, and criticality of the software, competence of the developers and stability of the requirements [7]. Boehm believes that a software development method will be the best when we use the "home ground" methods. Table 1 compares the home grounds for agile and plan-driven methods [8].

Table. 1 Home grounds for agile and plan-driven methods [8]

Home-ground area	Agile methods	Plan-driven methods
Developers	Knowledgeable, collocated and collaborative	Plan-oriented; adequate skills; access to external knowledge
Customers	Dedicated, knowledgeable, collocated, collaborative, representative and empowered	Access to knowledgeable, collaborative, representative and empowered customers

Requirements	largely emergent; rapid change	largely stable
Architecture	Designed for current requirements	Designed for current and foreseeable requirements
Refactoring	Inexpensive	Expensive
Size	Smaller teams and products	Larger teams and products
Primary objective	Rapid value	High assurance

Abrahamsson (2005) introduced agile methods as a possible solution based on the "home ground" for mobile software development. He shows an analysis of evidence the suitability of agile methods for development of mobile software, as shown in Table 2. [9]. In current software development methods, the agile method is suitable for mobile software development. In order to fulfill the special requirements of mobile software development, new methodologies are necessary [6].

Table. 2 Mapping agile home ground themes to traits observed in mobile software development [9].

Ideal agile Characteristic	Rationale	Mobile software
High environment Volatility	According to high variation of requirements, less need for up-front design & planning, need for iterative development approach.	High uncertainty, dynamic environment: Hundreds of new mobile phones are supplied each Year.
Small development teams	Small teams are able to react more rapidly, share information, less documentation is needed, etc.	In more of mobile software is developed in small or SME companies or development teams.
Identifiable customer	To avoid business misunderstanding	Potentially unlimited number of end-users. Identified to easily Business customer, e.g. distributor.
Object-oriented development environment	Most tools that support agile mode of development exist for object-oriented development platforms	E.g., Java and C++ used. Some problems in proper tooling e.g. for refactoring and test-first approach
Non-safety critical Software	Failures do not cause loss of lives. More agility can be pursued.	Majority of existing mobile software is for entertainment purposes. Mobile terminals are not reliable.
Application level software	Large embedded systems require extensive communication & verification mechanisms	While mobile systems are complex and highly dependent, mobile applications can be stand-alone applications
Small systems	Less upfront design needed	Size of mobile applications vary, but generally, they have less than 10000 lines of code.
Short development cycles	For the purposes of rapid feedback	Development cycles are different. Generally, mobile applications and services can be developed within 1-6 month time frame

3. REVIEW OF AGILE DEVELOPMENT FOR MOBILE APPLICATION

Agile methods allow software teams to respond quickly to changes. Agile methods reduce risks more than the waterfall software Engineering. The methods of agile development create the easy mobile app development and the resulting mobile apps are compatible with release. The main difference between desktop development and mobile app development is the need for rapid changes and permanent updates. Agile development is suitable for mobile app development. The agile methodology provides a continuous feedback from customers. By using agile methodologies, design and development of mobile app are performed in 2-3 weeks [10]. This study is a research on mobile application development using agile methods. This approach includes Mobile-D, HME, MASAM, and SLeSS as discussed below [10, 11].

3.1 Mobile-D

To overcome the challenges of mobile application development an agile development approach called the "Mobile-D ", has been suggested. This approach was introduced based on Extreme Programming (development practices), Crystal methodologies (method scalability) and Rational Unified Process. The "Mobile-D" approach is optimized for a team of fewer than ten developers and delivering a mobile application in a short time. This approach includes five phases shown in (Figure 1). The software development project using the Mobile-D approach is divided into five iterations. These phases are set-up, core1, core2, stabilize and wrap-up.



Figure. 1 Phases of Mobile-D software development process [11]

Each phase includes a sprint that consists of three different types of development days: Planning Day, Working Day and Release Day. The real agile activities within the methodology include Test Driven Development, Continuous Integration, Pair Programming, etc. [11].

3.2 Hybrid methodology design

Rahimian and Ramsin (2008) proposed a new agile approach that is Hybrid Method Engineering (HME) it was created from software Engineering techniques. It is based on a combination of agile methodologies, Adaptive Software Development (ASD) and New Product Development (NPD). The hybrid methodology is based on many practices like agility, review meeting, reusability support, market awareness, market-based architecture, etc. this approach was created in four iterations. In the first iteration, the methodology was detailed by adding practices generally found in agile methods. The second iteration included processes from New Product Development and a process concerned with introducing a new product or service to the market. In the third iteration, ASD concept was integrated into the method, and in the final iteration, prototyping was added to reduce likely technology-related risks. [6].

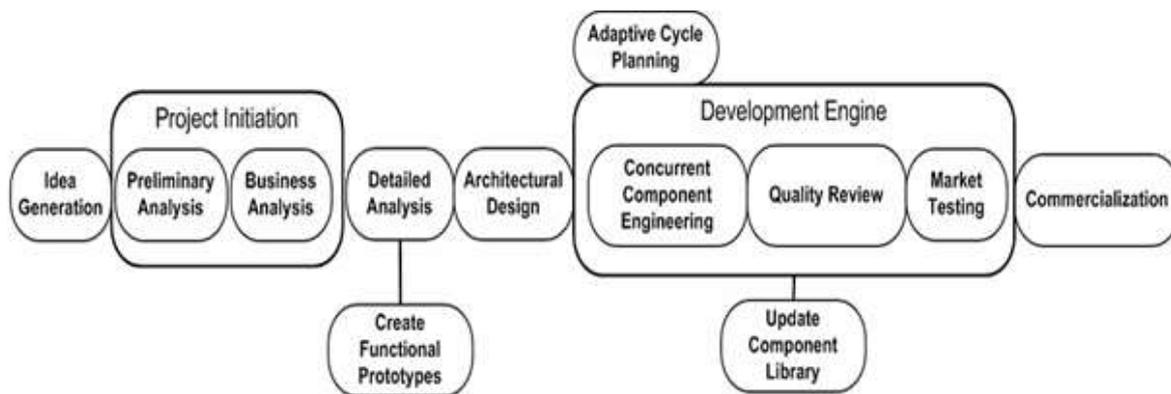


Figure. 2 Iterations of the hybrid methodology design process

3.3 MASAM

MASAM (Mobile Application Software development based on Agile Methodology) provides the process for developing the mobile applications using an agile approach. It is based on XP, AUP, RUP and software and, systems process engineering meta-model. MASAM has a simple life cycle with four phases (Figure 3).

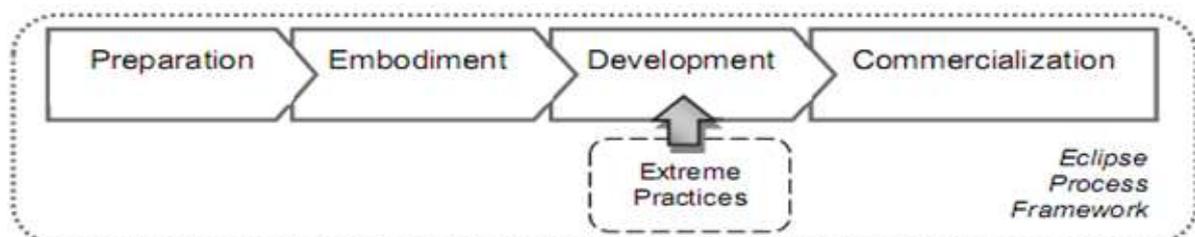


Figure. 3 Stages of MASAM

The Preparation Phase defines a summary and a first concept of the product and allocates roles and responsibilities. The Embodiment Phase focuses on understanding user’s requirements and defining the architecture of the software product. In developing Phase, that benefits from traditional agile principles to furnish an iterative Extreme Programming development sequence. The implementation of the software product is carried out through Test-Driven Development, Pair Programming, Refactoring and Continuous Integration, with a close relationship with iterative testing activities. Finally, commercialization Phase focuses on product launching and product selling activities [11].

3.4 SLeSS

Da Cunha and et al. (2011) proposed SLeSS, an integration approach of Scrum and Lean Six Sigma used in real projects of developing software for mobile phones. SLeSS was created from the Scrum methodology and consistent deliveries of the Scrum Sprints with the continuous process analysis and improvement model represented by the 5-phase DMAIC methodology (Define, Measure, Analyze, Improve and Control). (Figure 4)[12].

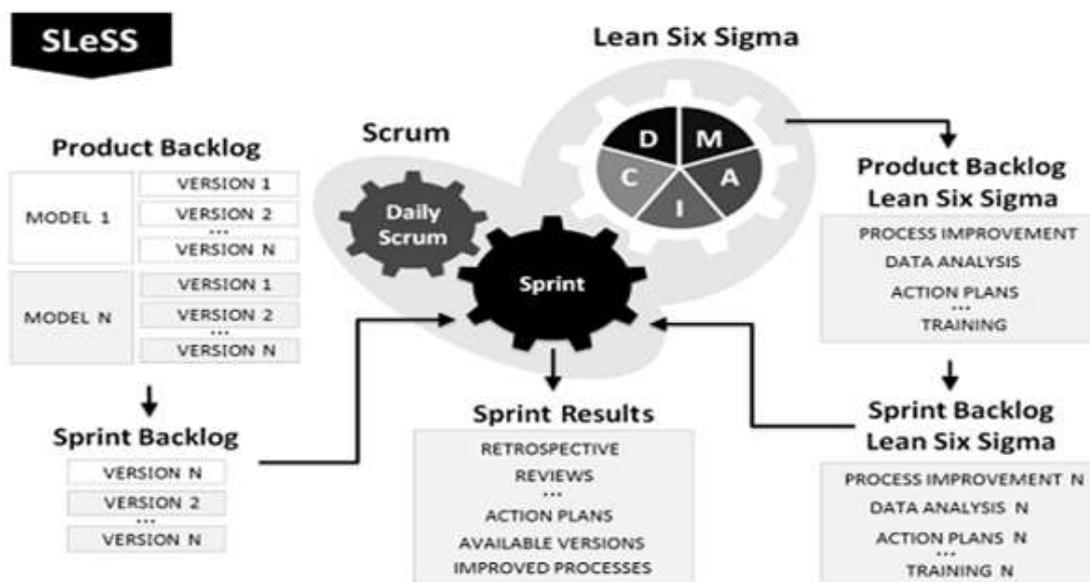


Figure. 4 Structure of the Implementation of Scrum Lean Six Sigma [11]

The implementation of SLeSS predicates an incremental approach, in which an agile method like Scrum is adapted to coexist with a plan-based methodology like Lean Six Sigma (LSS) [11].

Table 3 shows the summary of the proposed combination of agile and non-agile techniques for the development of mobile applications [13].

Table. 3 Mobile Application Development Processes using Agile Methodologies [13]

Approach	Mobile Development Process Description	Techniques
Mobile-D	An Agile Approach for Mobile Application Development	XP, Crystal, RUP
Hybrid Methodology Design Process	Designing an Agile method for Mobile Software Development - A Hybrid Method Engineering technique	ASD, NPD
MASAM	Development Process of Mobile software Based on Agile Methods	XP, RUP, SPEM
SLeSS	A Scrum and Lean Six Sigma Integration method for the Development of Software are suitable for Mobile Phones	Scrum, Lean Six Sigma

Table 4 shows the summary of strengths and weaknesses of mobile software development methods.

Table. 4 Strengths and weaknesses of mobile software development methods

Approach	Strengths	weaknesses
Mobile-D	Increased progress visibility, quick discover, and repair of technical issues, the low defect density in the final product and a constant progress in development [19].	Mobile-D is not perfect for complex or large systems, other weak points in terms of testing an application
Hybrid Methodology Design Process	Ensures a proper review of requirements, validates the results against the requirements and confirms it.	This approach does not include any case study or was not empirically tested on the real mobile software product.
MASAM	Suitable for small companies focusing on the development of mobile applications	This approach does not include any case study or implementation in a real-world project.
SLeSS	The SLeSS approach has been used in real embedded software customization development projects for mobile phones. This approach led to improvement in development and management processes.	There is not a popular case study in real-world projects

4. EVALUATION OF CHALLENGES / ADVANTAGES OF ADOPTING AGILE METHODS IN MOBILE DEVELOPMENT

Due to sensitive needs of mobile applications, adaptive software development methods are required. The agile approach is seen suitable for the mobile application and there is a need to explore different agile methodologies for the development of mobile applications. The key advantages of using agile methodologies for mobile applications is the iterative development that helps keep the focus on the consumer market, quick release to meet market demands and ease of fixing the issues for each version [3].

4.1 Reviews and adopting of agile methods in software projects Mobile

Research on agile development methods shows that there are significant methods in agile practices for speeding up the development of the mobile app. Some of these cases have been investigated in Table 5 [3].

Table. 5 Adopting of Agile methods in software projects Mobile [3]

Issue	Description
Adaptation of agile methods for highly volatile requirements of mobile apps.	Highly volatile requirements of mobile apps require adaptive software development methods. Agility is ideal for projects with high levels of uncertainty or variability. Agile development enables easy accommodating of change requests, frequent interaction with clients and helps in unifying the business requirements across teams by assigning right priorities and focuses.
Agile development to encourage stakeholder involvement in mobile projects	Stakeholder engagement in mobile projects enables monitoring of activities which improves and increase productivity, profit, and sustainability. This provides excellent visibility for stakeholders, enables rapid accommodation of stakeholder feedback and helps in rapidly rolling out suggested new features and ensuring that expectations are effectively managed.
Agile increases reliability and lead to continued use of mobile apps	Mobile users are usually less tolerant of error and crash in mobile apps. If an app crashes a few times, mobile users will easily switch to other application. Agile development with its iterative testing and quality assurance practices assists developers to build more quality and reliability through repeated cycles of testing.
Agile development empowers user experience for mobile Apps	Mobile apps run in limited environments and there are restrictions when downloading apps. If downloading an app takes several minutes, the user may try other apps instead. The Agile method allows developers to experiment different options in future sprints and regulate the design and features of apps to make the user experience is quick, clear, and seamless.
Agile fits the incomplete requirement nature of mobile projects	Mobile projects typically have deadlines and a quick time for market release. However, the initial requirements of mobile apps are generally incomplete, unclear, insufficient, and uncertain and change considerably during the development process. Developers commonly put out an app with a limited set

	of features in the first release and update it in later versions. This nature of mobile app development fit with the iterative nature of Agile development.
Agile methods fit the experimentation & adaptation of mobile software	Mobile apps become better with each release version. The process of refining and improving a mobile app is done with the help of customer feedback. Agile gives early visibility to users and fits this necessary need for next iteration.
Agile helps to identify risks in mobile projects at early Stages	The release cycles for mobile app development projects are getting shorter and there is the possibility of greater risks involved when dealing with tight releases. Small incremental releases are made visible to the product owner and product team. An adaptive approach and the clear visibility in agile development adds value to the business by identifying risks and ensuring that any necessary decision can be made at the earliest possible opportunity.
Agile development is best suitable for quick delivery and short development lifecycle of mobile apps	Mobile applications are often characterized by limitations such as rapid development and short development lifecycle. For the initial release, a minimum viable product with prioritized features is built and delivered as fast as possible, followed by additional features in later versions.

4.2 Reviews and explanations on failed mobile projects using agile approach

Adoption of agile approaches for mobile projects is the greatest concerns for organizations. We will discuss more leading causes of failed mobile projects using the agile approach, and barriers to further adoption of agile practices for mobile projects. Some of these cases have been investigated in Table 6 [3].

Table. 6 Explanation on failed mobile projects with using agile approach [3].

Issue	Description
Greatest concerns for organizations in the adoption of agile approaches for mobile projects	Due to lack of documentation, loss of management control, regulatory compliance, inability to scale, lack of up-front planning, management opposition, lack of predictability, development team opposed to change, lack of engineering Discipline, reduced software quality and quality of engineering talent (in descending order).
Causes of failed mobile projects using the Agile approach.	Due to culture at odds with core agile values, lack of cultural transition, broader organizational or communications problems, lack of management support, external pressure to follow traditional waterfall processes, unwillingness of teams to follow Agile, lack of experience with agile methods, insufficient technical training and newness to agile approach(in descending order).
Causes of failed mobile projects using the agile approach.	according to organization boundaries, customer cooperation, management support, common resistance to change, accessibility of personnel with right skills, trying to fit agile elements into a non-agile framework, project complexity, budget constraints, confidence in the ability to scale, perceived time to transition personnel with agile experience (in descending order).

4.3 Reviews on the most appropriate agile methods for mobile projects

There are many factors for selection of a methodology and practices for a project. The decision to adopt one methodology over the other depends on how well the team members know a particular methodology, how big the team is and how the team is organized. Some of these cases have been investigated in Table 7 [3].

Table. 7 The most appropriate agile methods for mobile projects [3]

Issue	Description
Most favourable agile methodology development of mobile applications	For developing mobile applications, most preferred methods for various agile practices are – “For Engineering Practices”: Scrum, XP, AM; “For Project Management Practices”: Scrum, AM, AUP, DSDM; “For Accept Changes in iteration at any time”: Scrum, Kanban, AM; “For Reduced Project Cost”: Scrum, Lean, XP; “For Schedule Accomplishment”: Scrum, AM, XP, FDD, AUP, Kanban; and “For Proper Resource Management”: Scrum, Lean, AM, Kanban.
most widely used Agile methodology for the development of mobile apps.	Most useful methods for developing mobile applications are Scrum, XP, and Lean software development methods.

5. WHY AGILE METHOD IS SUITABLE FOR MOBILE APPLICATION DEVELOPMENT?

Agile software development suggests an excellent opportunity and value for mobile development teams working on introducing a lightweight development process [14]. Abrahamsson (2005) studied the reasons why agile methods are suitable for mobile software development. He found that the various issues consist high environment excitability, small development teams, recognizable customer, object-oriented development environment, application level software, small systems and short development cycles [9].

Kannan (2011) believes that agile software development in mobile application development is suitable, because there are small teams, short deadlines, importance of usability, fast delivery and less complexity. He suggested seven methods in which agile development methods increase the development of mobile apps that consist experimentation and adaption nature of mobile apps; reliability that leads to continued use of apps; development of agile sprints into mobile app model, response to technology changes; rapidly accommodating customer feedback [15].

6. ADVANTAGES OF USING AGILE FOR MOBILE APPLICATION DEVELOPMENT

Agile methodologies can be used for changing business requirements and for better management of the software development lifecycle. It provides processes that facilitate communication between the developer and the customer. In fact, agile methods provide significant solutions for increment speeding up of the development of mobile app projects [9]. Agile development methods increase the quality of the product in mobile application [16].

6.1 Release and delivery

Agile approaches create products and deliver them to the customer in the minimum possible time. So the first delivery reaching the customer with prioritized features in a short time causes customer satisfaction. Fast delivery of product and inquisitiveness of new versions cause the market value increase for that product [9].

6.2 Responding to changing market needs

Technology is enhancing and changing with very fast in mobile markets. It thus needs to cope with changing market trends and customers' requirements efficiently. The Agile approach is people oriented and accept to changing needs. So by implementing agile approaches in organizations can be increased the profit [9].

6.3 Risk identified in primary stages

Agile is an adaptive approach. Though it cannot predict all the problems at the beginning of the project the team must well prepare in the face of any risk in the project. Risks are identified at earlier stages because there are collaboration and feedback with customers in different phases of the project. In the traditional development, we release the product at the end of the project. So, major flaws may exist in the product. But in agile methods, we release the product in different tags. So we will overcome all the risks that may occur during product development [9].

7. REVIEWS AND DESCRIPTIONS ON AGILE AND LEAN PROCESS MODEL "ALP-MOBILE MODEL" TO OVERCOME CHALLENGES IN MOBILE APPLICATION DEVELOPMENT

Vallon et al. (2015) proposed a new process model called ALP-mobile which is a combination of agile and lean methodologies to overcome challenges in mobile application development. "ALP-mobile" covers the complete project lifecycle in mobile application development including implementation and testing of the product, and suitable maintenance of the software in order to ensure high quality. "ALP-mobile" uses four different types of meetings: a kick-off (once), planning (on demand), standups (daily) and retrospective (weekly). The workflow of the model is shown in Figure 5 [4].

ALP-mobile executes on mobile software projects which are developed for a specific customer. After the introductory meeting, the kick-off meeting is done. The kick-off meeting includes the determination of the technology stack which is associated with the activity of defining the development approach. After the kick-off meeting, the main focus is to put on engineering requirements. The product owner defines user stories according to the requirements of the customer and schedules the planning meeting at which the user stories are estimated. Early prototyping is strongly encouraged in ALP-mobile, leading to increased feedback from the customer in the early project. Communication is essential in all activities of ALP-mobile. The close cooperation with the customer fits the lean practice of customer participation for development, a lean-style kanban board in ALP-mobile provides a clear mapping and status report of the value stream. So it is a main element in the processes. In this model steps on the board can be tailored to each specific project environment. The Backlog column is filled with the user stories and the development team is ready to implement the first work items from the selected column on the kanban board. The Selected column is maintained by the product owner according to the priority of the user stories. The process is now controlled via the WiP (Work in Progress) limits on the kanban board. The overall

goal is to establish a continuous flow. After a work item is implemented and tested, it can get pulled into the Pending column of the board. The sum of the stories in that column shows the current version of the software prior to the first distribution. The product owner is responsible for keeping the user stories update and requesting a new planning meeting if new user stories need to be estimated.

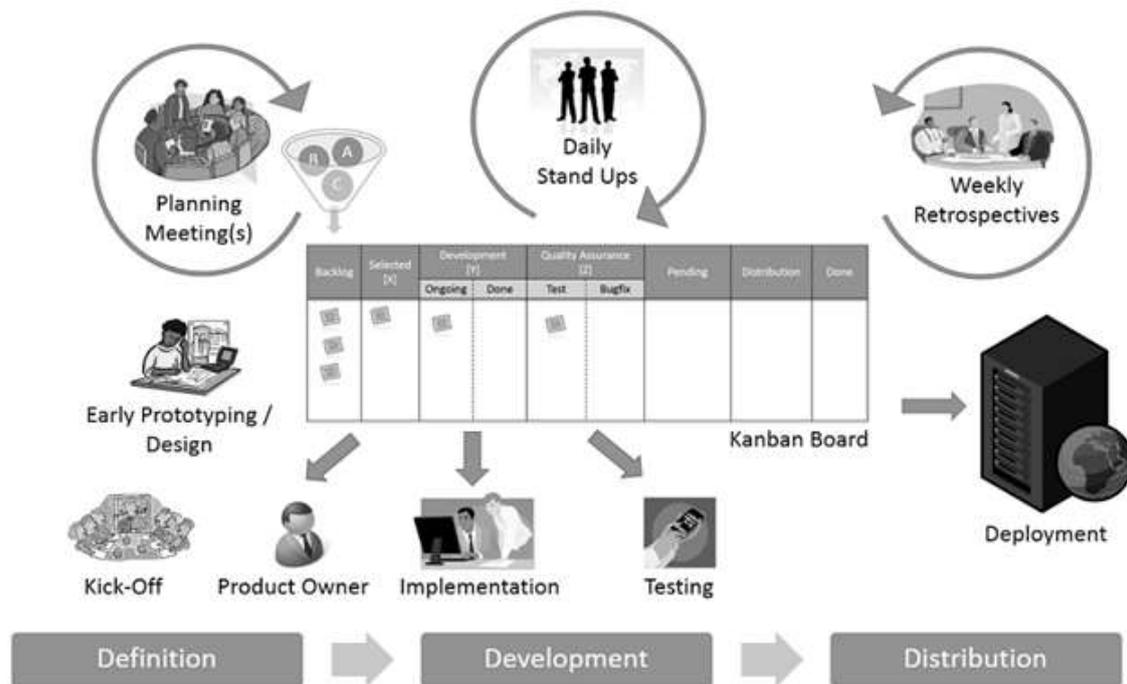


Figure. 5 The ALP-mobile process workflow [4]

The iteration of the planning meeting and the continuous changes in the backlog show a clear difference to traditional software process models in which completed phases are not executed again. In agreement with the customer, a version of the software is then distributed. After the distribution, the work items can get pulled into the done column. The process is not finished with the first distribution of the software. ALP-mobile is very efficient and productive in the very short-lived mobile market. Retrospective meetings are held in order to review the development of the product. This meeting is scheduled weekly. Also, a Scrum-style daily standup-meeting takes 15 minutes to facilitate intra-team coordination. Also, Studies showed that ALP-mobile has the potential to bring great benefits to organizations working in the field of mobile application development [4].

8. DISCUSSION OF ISSUE RELATED TO AGILE METHODS IN MOBILE PROJECTS DEVELOPMENT

While the reviewed agility-based frameworks that are suitable for mobile environments, we need to analyze and validate this claim. To solve this question, we introduced a discussion in three thematic areas [11].

8.1 Are agile methods the best fit for the needs of the mobile business environment?

Implementing agile methods enables the adaptation of processes and practices to the unstable needs of the mobile domain. Agile methodologies establish their core values in the possibility of focusing on the working product and responding efficiently to changes. Mobile apps should be developed quickly and keep up a low price to be successful in a market. Agile methods accepted this business model effectively to understand the market, structure the product and release it in a short time [11].

8.2 Are Agile methods addressing the needs of the mobile operative environment?

It is hard to argue for a direct effect on the end product. Considering the constraints of the mobile

Environment, it is not clear that there may be problems with injected software development problems. Agile methods collaborate to create a development life cycle appropriate to meet the business needs of the mobile environment. Design guidelines and best practices provide mobile-specific development practices that aid to implement a product that is related to this domain (Figure 6) [11].

Software quality metrics are to monitor the activities and supply the data that support the measurement tasks required by the high-level development process.

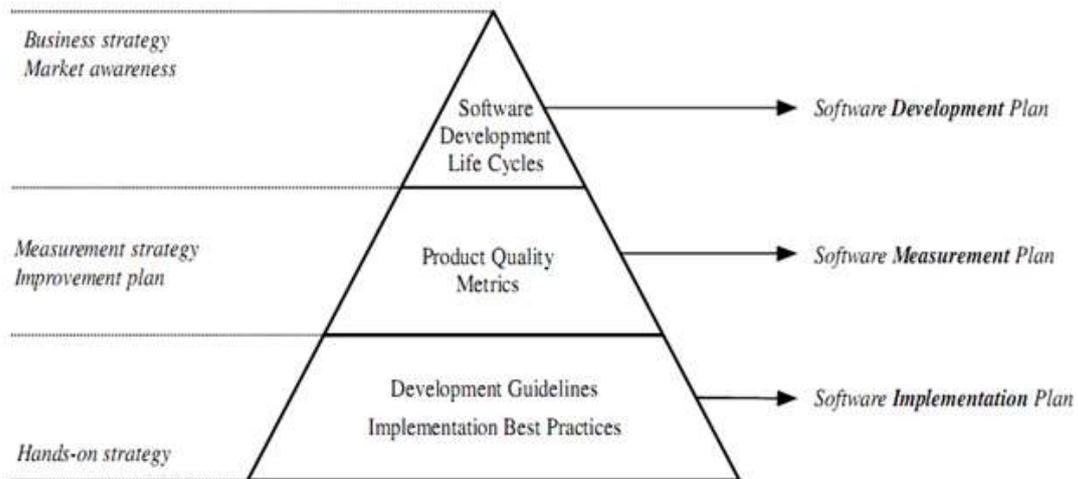


Figure. 6 Organization of software lifecycles, product assurance and development guidelines

9. CHALLENGES AND OPPORTUNITIES FOR MOBILE TESTING USING AGILE METHODS

Development and test mobile applications with the quality mobile application is one of the challenges to be solved by the software engineering professional. There are many challenges in developing and testing mobile application in agile environments. Testing of mobile applications is very important in the modern era. Testing causes the discovery errors or bugs in codes [17]. Testing ensures that the project will continue and that any problem will be more easily solved. Test automation primary and connecting functional and even load and performance tests to Continuous Integration as part of regression testing, the development team takes the responsibility for bugs in the code. The agile performance testing approach also increases transparency all over the project, enabling developers to more easily communicate with all stakeholders as to their progress. This technique can ensure that the project completes with budget and will be released on time [10, 18].

10. CONCLUSION

In this Research, we showed that agile methodologies are the best methods for mobile software development process. For challenges of mobile application development, agile development is a suitable method for software development in mobile devices. Agile methods allow software teams to respond quickly to changes. In the present research, mobile application development is discussed using agile methods like Mobile-D, HME, MASAM, and SLeSS. Agile methods can provide significant solutions to increment speeding up of the development of mobile application projects.

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