

## **A Study on the Application of Agile Methodology to Improve Software Development Quality**

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### **Abstract**

*There are many limitations in applying agile methodology to projects so far. In fact, projects overlap with other development methodologies and management processes, resulting in confusing progress, while there are often cases where the benefits of agile cannot be embraced due to a lack of understanding of agile processes and the organization's inability to adapt to change. It is an important role of information system development to improve the quality of agile application projects by discovering the problems and improvements in these cases. In this paper, we analyze the differences between existing development and project management methods and agile, and analyze agile processes. The optimal agile methodology was proposed by analyzing and applying methodologies established and applied mainly by large domestic development companies. In addition, the effectiveness was verified through a questionnaire of IT experts, and the result of the questionnaire was verified to be 4.75 points on a 5-point scale.*

**Keywords:** *Project Management, Agile Methodology, Information System Development, Management Process*

### **1. Introduction**

Numerous development methodologies have evolved and developed to improve software development quality and productivity. Starting from an early methodology such as “code writing, modification, and code rework”, and developing into a more structured and formal methodology like a waterfall model, numerous methodologies have been created and applied to control and manage software production. In the 2000s, a new paradigm called agile development methodology emerged, making the interaction between software developers, working software, collaboration with customers, and responding to change as major values, with great achievements [1]. Agile methodology is sometimes understood to mean lighter weight, but if the value of agile is missing, process lightening itself cannot mean agile [2].

There are many limitations in applying such agile to projects so far. In fact, projects overlap with other development methodologies and management processes and are confusing, but there are often cases where the of agile [3]. It is an important role of information system development to improve the quality of agile application projects by discovering the problems and improvements in these cases. In this paper, we analyze

the differences between existing development and project management methods and agile, and analyze domestic and international application status and agile processes. In addition, a new agile methodology is proposed by analyzing and applying methodologies established and applied mainly by large domestic development companies.

## **2. Related Work**

### **2.1 Agile methodology**

Agile software development starts with a response to the irrational parts of the traditional waterfall model. In other words, the traditional waterfall model failed to meet the changing customer requirements by sticking to the original plan, and the flexibility of the project disappeared and the delivery of customer value was not easy by controlling the requirements change [4]. Therefore, we sympathize with the necessity of an alternative to replace the heavy methodology centered on documents and outputs, and it is called the Lightweight Process. In 2001, the Manifesto for Agile Software Development declaration began in earnest.

The Agile main principles follows as below [5][6]:

- . Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
- . Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
- . Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
- . Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
- . The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
- . Working software is the primary measure of progress.
- . Agile processes promote sustainable development. The sponsors, developers and users should be able to maintain a constant pace indefinitely.
- . Continuous attention to technical excellence and good design enhances agility.
- . Simplicity, the art of maximizing the amount of work not done, is essential.
- . The best architectures, requirements and designs emerge from self-organizing teams.
- . At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

The Agile Manifesto and its principles show the basic philosophy of Agile and are linked to everything applied to Agile's best practices [7].

### **2.2 Difference between traditional development and agile methods**

Traditional development methodology is the oldest development methodology among software development methodologies and is the most widely distributed methodology. The traditional point of view development methodology takes a top-down approach to managing projects and creating different systems [8].

The advantage of traditional development methodologies is that they are very logical. The downside is that problems arise when humans are involved. It is difficult to react quickly to change because it is only possible to proceed to the next step by completing the previous step. In addition, since the management area for various interfaces is unclear and the focus is only on functional implementation, there is a lack of guidance on the overall management area of the project [9].

The Agile development method is a software development method to pursue the efficiency of the

development process and flexible coping with changes in requirements that could not be obtained from the existing traditional development method. In the agile development method, several practical and efficient practice methods centered on developers were introduced [10].

The following <table 1> is a comparison of the differences between agile methodology and traditional development methodology.

**Table 1. Agile methodology versus traditional methodology**

Classification	Agile Methodology	Traditional Methodology
Planning	Experience-based process of frequent planning and updating	Plan-based process of detailed planning
Requirement Management	Relatively easy to change and add	Collection of initial requirements and strict change management
Design and Development	Early testing with simultaneous iteration of coding and unit test	Coding all functions at the same time by each team and post-testing
Progress Review	Check whether the release software is running every iteration	Review the milestone document
Test	Functional verification through development and test for each small unit function	System integrity is guaranteed in unit test, integration test, and system test.

Although there are many philosophical differences between the traditional methodology and the agile methodology, the PMBOK implementation method and the agile methodology implementation method can be quite largely compatible. According to the authors of the Capability Maturity Model (CMM), in the Project Management Institute (PMI) (PMI), PMBOK is the best practice guide, and organizations must decide how to implement PMBOK. The difference between the two methodologies lies in the difference between how the team is 'directed and supervised' and the 'self-managed team' and how and when it will be implemented. Among the 9 knowledge areas of PMBOK, as shown in <Table 2> below, Integration Management, Scope Management, Time Management, Human Management, and Quality Management area is clearly different from agile project management [11].

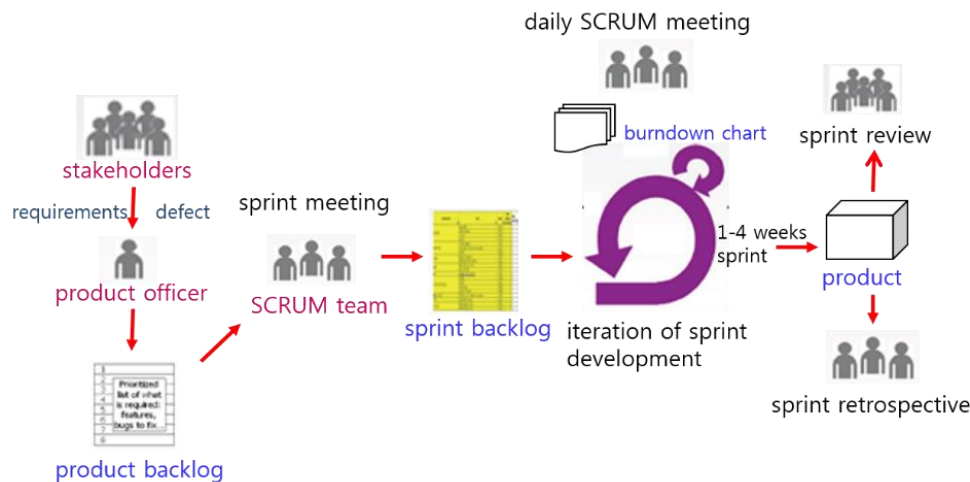
**Table 2. PMBOK versus Agile methodology**

Classification	PMBOK	Agile Methodology
Integrated Management	Determine scope, WBS, schedule, and controls at the start of the project	Simplify the integrated change management process
Scope Management	Trial not to change the scope	Predict and reflect changes in development scope
Schedule Management	Supervise, control, coordinate and modify schedules as needed	Priority implementation of the highest value determined by customers
Quality Management	Define quality assurance and quality management according to procedures	Determine tools and skills with the project team for testing, execution and reporting
Human Resource Management	Organizational planning is the process by which roles and responsibilities are assigned	Approach in a way that lets you organize yourself

### 3. Agile process and application method

#### 3.1 SCRUM development processes

Recently, examples of applying SCRUM to projects are increasing, and good examples can be easily shared based on the experience of various project sites. The main feature of Scrum is that it develops the most important requirements first, and it frequently reflects customer feedback through short iteration cycles (called sprints and within 2-4 weeks). The end result of the sprint is the working software, which is reviewed with the user and the feedback is reflected in the next sprint plan. This iterative process is performed repeatedly until the final requirements are satisfied. The Scrum development methodology process is depicted in <Figure 1> [12].



**Figure 1. SCRUM development process**

The general SCRUM process is summarized as follows [1][13].

- ① Create a product backlog that divides the needs of various stakeholders into functional and non-functional. The product backlog is the product roadmap. This is a prioritized arrangement of everything the team can complete.
- ② Select the function to be developed in the next development period (sprint) in the product backlog. It also looks at how features that couldn't be developed in previous sprints will return to the next sprint. It also estimates the amount of time the work needs to be done in this sprint.
- ③ In the product backlog, each item is divided into individual work units according to priority, and the sprint backlog is created and recorded.
- ④ Conduct meetings according to the daily scrum and work according to the sprint backlog during the sprint period.
- ⑤ After the daily scrum meeting, update the sprint backlog and extinction chart, and specify the product backlog.
- ⑥ After the sprint is over, demonstrate and share the sprint results through a sprint review.
- ⑦ Reflect on the sprint period through sprint retrospect and discover areas of improvement for the next sprint.

### 3.2 Efficient application of SCRUM

Scrum is also called a framework. A framework is literally a skeleton. In order to successfully apply Scrum, it must be possible to apply Scrum according to the situation according to the unique characteristics of the organization and development team. Scrum is applied in different ways depending on the situation of each development team [1].

In addition, since there is no specific practice method for Scrum, the basic concepts such as daily scrum meeting, burndown chart, and backlog are the same, but in the process of actually applying this, various methods are used according to the individuality of each team. In particular, the Scrum Master is a new type of manager known through Scrum, which is the driving force behind Scrum practice. In other words, it is necessary to establish a practice method suitable for the field and make it implemented in the actual project [13].

## 4. Proposal of improved agile methodology through examples

Unlike existing waterfall development, Agile development is a method in which users, developers, and testers form a team to develop user scenarios, code, and test quality within a short period of time to carry out the entire project. Agile development increases the quality of the final product and improves development efficiency. Large IT service companies are also actively considering introducing agile development methods with these advantages. Therefore, as the case of two large IT companies, we would like to propose an improved agile methodology that can be efficiently used by domestic IT companies. Company A is applying an agile development method to the next-generation system construction project in the public sector and to the logistics system expansion construction project.

### 4.1 Company A's Agile Methodology

Company A has officially released an agile development methodology as one of the company's standard development methodologies. The Agile methodology was basically written based on the Scrum process. Scrum avoids the existing division of labor to perform only specific roles, seeks to solve problems by organizing the whole team on its own, and instead of giving orders from the manager, the team members have their own authority and responsibility. Is the leader's role, which finds and resolves obstacles or risks experienced by team members [14].

Iteration, which is a unit of development cycle, draws targets to be implemented within the "Iteration Planning Meeting" activity from the entire requirements list (product backlog), and establishes a plan at a level that can generate actual physical source codes and outputs. Design, implementation, and testing are carried out in parallel, and functions implemented at the end of iteration are shared with the whole through a demo called 'Repeat Review.'

During this period, a lot of communication actually occurs, potential risks emerge, and misunderstood requirements may be redefined. Also, at the beginning of the project, it has the advantage of deriving interface requirements that need to be linked between modules and UI/UX standards such as screen standards, message standards, and menu structures. The following <Table 3> summarizes the activities, tasks, and outputs according to each stage of Company A's agile methodology.

**Table 3. Summary of company A's agile methodology**

Phase	Activity	Task	Outputs
Requirement	User Story	Identifying user story	Product backlog

Definition	Definition	Definition of user story priority	Product backlog(priority)
Release Plan	Release Plan	Release schedule	Product backlog(release schedule)
		Selection of release story	Product backlog(release story)
		Estimation of user story	Product backlog(estimates)
Iteration Execution	Iteration Plan	Iteration goal	Iteration backlog
		Selection of user story	Iteration backlog(user story)
		Definition of development task	Iteration backlog(development task)
	Daily Plan	Daily SCRUM meeting	Meeting minutes
		Iteration backlog update	Iteration backlog(status update)
	Design and Build	Architecture definition	Architecture definition
		Design	UI design, DB design, Use case design
		Unit test case writing	Unit test case code
		Source code writing	Source code
	Test	Unit test	Unit test plan
		Incremental integration	Test scenario / case
		Acceptance test	Iteration backlog(update)
	Iteration Review	Function demonstration	Function results
		Function evaluation	Meeting minutes
	Release	Integration / System Test	Integrated test plan and design
Integrated test			Integrated test results
System test plan and design			System test plan, System test scenario/case
System test			System test results
Release Review		Manual writing	Manual
		Product release	Meeting minutes

#### 4.2 Company B's Agile Methodology

Company B is focusing on the areas where the development lead time is short and there are not many external interfaces. Company B applied an agile development method in the project to detail the system construction status, and based on this, minimized the issues caused by the decision delay so that the requirements could be immediately reflected [15].

Company B's agile methodology reflects the iterative development practice based on the Scrum Method to build a system with a short iteration cycle, and prevents integration errors early and maintains a certain level of quality. It reflects Continuous Integration and Continuous Testing Practice [16]. Company B's application of this agile methodology not only provides a framework for effectively constructing a system by reducing waste as much as possible, but also provides a self-organized team to actively carry out projects, freeing from the way of working passively. The following <Table 4> summarizes the activities, tasks, and outputs according to each stage of Company B's agile methodology.

**Table 4. Summary of company B’s agile methodology**

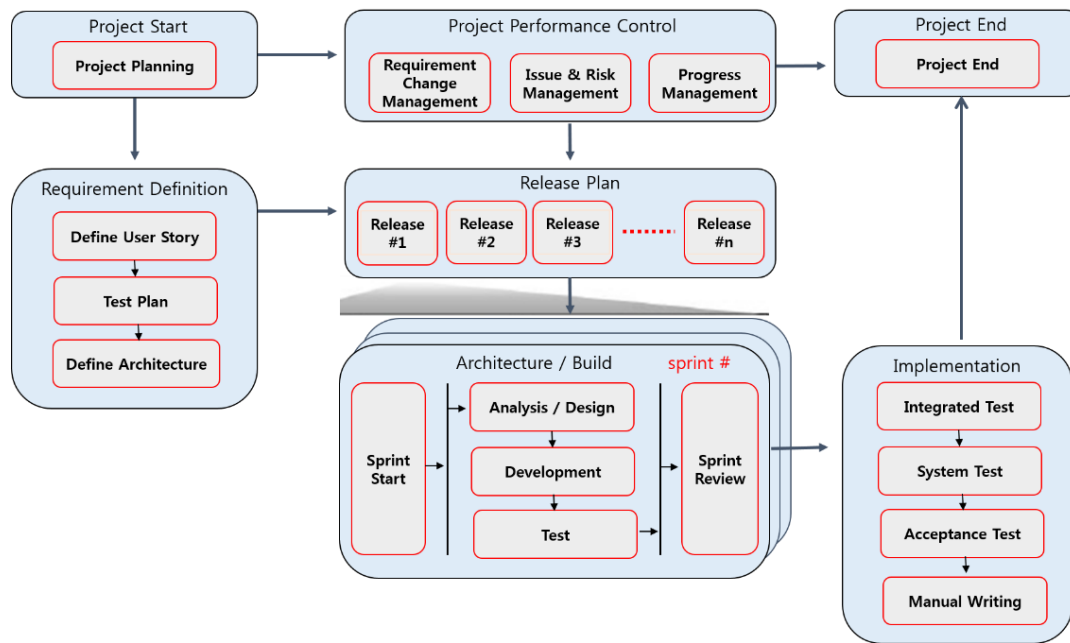
Phase	Activity		Task	Outputs
Project Initiation	Project planning		Project planning	Project plan, Schedule plan
Requirement Definition	Requirement definition		User story define	User story
	Development strategy establishment	Test plan establishment		Test plan
		Development plan establishment		Product backlog, Schedule plan
	Architecture vision establishment		Architecture define	Architecture definition
	Performance control	Requirement change management		Product backlog, User story
		Issue & risk management		List of issue & risk
		Progress management		Schedule plan
Architecture	Architecture (Sprint n)	Sprint Start	Sprint plan	Product backlog, Sprint backlog
		Architecture Development	Define standard	Development standard, UI standard, Data dictionary
			Development environment	Development environment
			Execution architecture	Architecture definition, Source code
		Pre-development	Application design	Screen definition, ERD
			Test scenario definition	Test scenario
			Coding and unit test	Source code, Test log
			Integrated build	Deploy file
		Sprint Review	Integrated test	Test scenario(result), Defect reports
	Customer review		Customer review result	
	Performance Control	Review	Review result	
		Requirement change management		Product backlog, User story
		Issue and risk management		List of issue and risk
	Progress Management		Product backlog, Sprint backlog Extinction chart	
Build	Build (Sprint n)	Sprint Start	Sprint plan	Product backlog, Sprint backlog
		Development	Application design	Screen definition, ERD
	Test scenario definition		Test scenario	
	Coding and unit test		Source code, Test log	
	Integrated build		Deploy file	
	Integrated test	Test scenario(result), Defect reports		

		Sprint Review	Customer review	Customer review result
			Review	Review result
	Performance Control	Requirement change management	Product backlog, User story	
		Issue and risk management	List of issue and risk	
Progress management		Product backlog, Sprint backlog Extension chart		
Execution	Execution Plan		Release plan	Release plan
	Test	System test		Test scenario(result), Defect reports
		Acceptance test		Defect reports Acceptance test result
	Conversion and Release	Operation environment		Operation environment
		Data conversion		Converted data
		System release		Operation system
	User Education	Manual writing		User manual, Operation manual
		Education and training		Education result
	Performance Control	Requirement change management		Product backlog, User story
		Issue and risk management		List of issue and risk
		Progress management		Schedule plan
	Project End	System Transfer		System takeover
Customer inspection				Final inspection confirmation

#### 4.3 Proposal of improved agile methodology

It can be seen that the common point of agile methodology established and applied by large domestic companies is that they define core products based on Scrum. In the case of Company A, the procedure consists of 4 stages of request definition, release plan, iteration, and release, and in case of Company B, it consists of 4 stages of request definition, architecture, construction, and implementation. Company A performs architecture establishment at the iteration stage, and Company B performs at the architecture stage. It can be seen that in the case of Company B, the project management methodology is additionally applied to the agile methodology. Company B's methodology is more specific than company A's because it has more repetitive activities. However, the proposed agile methodology refined around the common and important activities of the two companies' methodology and the SCRUM methodology was derived as shown in <Figure 2> and <Table 5>.





**Figure 2. Proposed Agile Framework**

The proposed new agile framework operates in the following process.

- ① If the project is started in the [Project Start] stage, it proceeds to the [Define Requirements] stage and the [Project Performance Control] stage.
- ② The architecture defined in the [Requirement Definition] stage is proceeded to the [Release Plan] stage, and at the same time, the release plan is made in the [Release Plan] stage along with the progress of [Project Performance Control].
- ③ According to the defined release plan, build the architecture in the [Architecture / Build] stage, and repeatedly implement all the releases planned in the [Release Plan] stage.
- ④ After testing the implemented architecture in the [Implementation] stage, the project is finished in the [Project End] stage.

**Table 5. Proposed agile methodology**

Phase	Activity	Outputs
Project Start	Project planning	Project plan, WBS
Project Performance Control	Requirement change management	Product backlog, User story
	Issue and risk management	List of issue and risk
	Progress management	Product backlog, Sprint backlog Extinction chart, WBS
Requirement Definition	User story definition	User story, Product backlog
	Test plan establishment	Test plan
	Architecture definition	Architecture definition

Release Plan		Release schedule plan	Release plan
Architecture / Build	Sprint start	Sprint plan	Sprint backlog
	Analysis/ Design	Architecture build	Architecture definition, UI Standard, Development Standard
		Application analysis/design	Screen definition, ERD
	Development	Application development	Source code
	Test	Unit test	Test scenario(result), Results
	Sprint Review	Customer review	Sprint review(customer), Results
Review		Review result	
Implementation		Integrated test	Integrated test scenario, Test results
		System test	System test scenario, Test results
		Acceptance test	Acceptance test results
		Manual writing	User manual
Project End		Project end	System Acquisition Statement, Final inspection confirmation

#### 4.4 Verification of output through application of the proposed agile methodology

A survey was conducted to verify the output of the proposed agile methodology applied project. The subjects of the survey were 13 IT auditors (46.4%), 2 project managers (7.14%), 5 developers (17.9%), 4 analysts and designers (14.3%), 1 database manager (3.57%), 3 infrastructure managers(10.7%) with a total of 28 people participated. The following <table 6> shows the survey results for agile output. As a result of the questionnaire on the proposed agile methodology elected, each item was marked with values of very necessary (5 points), necessary (4 points), normal (3 points), not necessary (2 points), and absolutely not necessary (1 point). The item conformity verification according to the survey results was summarized as a nonconformity opinion that “very necessary, necessary” is appropriate, and “not necessary nor necessary” on a normal basis. As a result of the application, it was verified that it was suitable with 4.75 points on the 5-point scale.

**Table 6. Results of a survey on the proposed agile output**

Outputs	Questionnaire query	Fitness	Usual	Unsuitable	Average	S. Dev.
User Story	Have all system-related requirements been derived?	28	0	0	4.75	0.43
	Can you understand and use the details of the requirements when implementing the user story?	28	0	0	4.71	0.45
	Does the priority of important business functions or common functions enable smooth process management?	28	0	0	4.68	0.47
Product Backlog	Does the product backlog include a complete list of features the team will implement?	28	0	0	4.75	0.43
	Are the changes made through the change list and change request reflected in the product backlog?	28	0	0	4.68	0.47

	Does the product backlog include a list of defects that occurred in the finished user story?	28	0	0	4.61	0.49
	Is the story point of the user story calculated at an appropriate level compared to the reference point?	28	0	0	4.61	0.49
	Is the risk priority analyzed by reflecting the importance and difficulty level derived from the user story creation?	28	0	0	4.71	0.45
	Is the user story assigned to the sprint in consideration of the risk priority or the relationship of the implementation?	28	0	0	4.68	0.47
Release Plan	Is there a release schedule in the product backlog?	28	0	0	4.68	0.47
	Has the target story been selected for release?	28	0	0	4.64	0.48
	Is there an estimate of the user story in the product backlog?	28	0	0	4.64	0.48
Sprint Backlog	Does the sprint backlog contain user stories for the team to implement?	28	0	0	4.93	0.26
	Are the criteria for completing the user story clear?	28	0	0	4.93	0.26
	Does the work time not exceed the sprint period?	27	1	0	4.86	0.44
	Are the tasks detailed enough to be completed within a given amount of time?	27	1	0	4.82	0.47
	Are the changes made during the sprint reflected in the sprint backlog?	28	0	0	4.96	0.19
Sprint Review	Are customer opinions continuously reflected through customer participation?	27	1	0	4.86	0.44
Total		27.83	0.17	0	4.75	0.42

## 5. Conclusion

Project stakeholders demand better software quality, shorter cycle times and faster product launches. To satisfy this, the IT environment is trying a lot of efforts such as clear requirements management, application of automation tools for development productivity, and reinforcement of testing activities for quality assurance.

Software development becomes more complex, and requirements are generally not clear at the beginning of development, and it is formalized through a lot of trial and error as it leads to the design and development stages. As one of the many ways to solve this problem, agile is recently established for organizations and applied to projects. However, there are many limitations in applying agile methodology to projects so far. In practice, projects are confusing with other development methodologies, but there are often cases where agile processes are poorly understood and organizations are unable to adapt to change and thus cannot accept the benefits of agile. It is an important role of information system development to improve the quality of agile application projects by discovering the problems and improvements in these cases. In this paper, the difference between the existing development and project management methods and agile was analyzed, and the agile process was analyzed. The methodology established and applied by large domestic development companies

was analyzed and applied to propose an optimal agile methodology, and the effectiveness was verified through questionnaires of IT experts. As a result of the questionnaire, it was verified that the proposed methodology with 4.75 points on the 5-point scale was appropriate.

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