

# CHALMERS



## How to Migrate from Waterfall Development Approach to Agile Approach

*Master of Science Thesis in the Master's Programme International Project Management*

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Department of Civil and Environmental Engineering  
Division of Construction Management  
CHALMERS UNIVERSITY OF TECHNOLOGY  
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# Preface

The motivation of this research comes from the difficulties within the author's own working experience in migration from the waterfall development approach based on Capability Maturity Model (CMM) to an agile approach. At the same time, literature review and observations from other companies also contributed.

In practical projects there are difficulties in migrating from the waterfall development approach based on CMM to agile approach. This research focuses on how to address the difficulties and also gives suggestions of how to migrate smoother.

The purpose of this research within this thesis is focused on how to support migration process, in order to assess better project performance in software development.

# List of Abbreviations

CL	Communication Links
CMM	Capability Maturity Model
CR	Change Requirement
ISO	International Standardization Organization
KPI	Key Performance Indicators
PD	Power Distance
PDCA	Plan, Design, Check, Act
QA	Quality Assurance
SDLC	Software Development Life Cycle
XP	eXtreme Programming

# Glossary

<b>Agile</b>	One of the software development methods, based on iterative and incremental change.
<b>Capability Maturity Model</b>	One development model in IT industry, to improve the existing software development processes.
<b>Change Management</b>	The management of changing or rebuilding the existing items of project process.
<b>Communication Management</b>	The management of transitioning information between individuals and teams.
<b>Deductive Reasoning</b>	One of the research methods, from theories to data analysis, then confirmed related theories.
<b>eXtreme Programming</b>	One of the Agile processes, it is known as XP.
<b>Iteration</b>	In a limited time period, it delivers after requirement analysis, design, implementation and test phases. It can be a software release or one of the tasks of one release.
<b>Process Development</b>	Involves greater creativity, participation, and collaboration in order to get more value from the project.
<b>Project Management</b>	Implement project activities in high efficiency to meet stakeholders' interest under the limitation of time and cost.
<b>Qualitative</b>	One of the data collection methods, using limited quantity data to analysis.
<b>Scrum</b>	One of the software development processes, common used in Agile approach.
<b>Software Development</b>	The whole process of software development,

<b>Lifecycle</b>	from project beginning to project closeout.
<b>Stakeholder</b>	A party that affects or can be affected by the project.
<b>Waterfall Development Approach</b>	One of the software development methods, it is a sequential design process, from collecting customer requirement to deliver.

# Structured Abstract

- Objective

To explore ways to make use of the knowledge of communication management and process management when migrating from waterfall development approach to agile approach from the environment development, human resource and communication aspects.

- Methods

Deductive reasoning and a qualitative method are adopted in this research. Data in relevant literature and interviews are the main collection resources. Fifteen books and twenty-eight articles have been studied and analyzed. Five participants have been interviewed who are all from international companies in different levels of management.

- Results and Conclusion

Analysis is undertaken through the literature review, one case study provided by Donald (2003) and interviews. As conclusion of this research, suggestions are given on how to migrate. They are divided into four parts: preparation, mind-set, people factors and communication.

Keywords: Waterfall development approach, CMM, Agile development approach, Migration, Process Development, Communication Management, Project Management



# 1 Introduction

The purpose of this research is to provide suggestions for how to support migration from a traditional software development approach to an agile approach. This research is mainly motivated by the difficulties within the author's own working experience in migration. In order to make migration smoother and to decrease the negative sides from the agile approach, suggestions which are related to process, strategies and attention points are achieved. A qualitative research method is used in this research. It is implemented by literature review and interviews. The interviewed people are from five different development situations and different management levels.

This chapter gives the background of this research. Then research statement, research purpose and research questions are previewed. In order to make this research structure more clear, thesis structure is explained. Finally, a research structure along with the rational and possible implementations is discussed.

## 1.1 Background

Software development approaches are gradually being developed according to the changes of software techniques and new requirements from customers (Ambler, 2002). At present the environment of software development is dynamic. It is needed for the organization to urgently adapt processes, development methods and strategies when adjusting to new situations (Nerur et al, 2005). This kind of organization is capable of adjusting change to satisfy the fluctuating demands. However, the traditional, plan-driven software development approach is lacking the flexibility and capability to dynamically change and adjust the development process (Nerur et al, 2005). "Agile development has recently attracted huge interest from software industry" (Smite et al. 2002, p.7). As a consequence, more organizations start to adopt the agile development approach. Migration is the compulsory procedure for such organizations to transfer from the waterfall development approach to an agile approach.

In practical projects difficulties and challenges exist in migrating. Taking an example of communication technique, the agile approach needs fast and high efficiency communication management during software development. However, the waterfall development approach obeys common communication tools for regular information transfer and discussion in most situations (Ambler, 2002). There are more difficulties for the organizations which are located in global sites. Because there are different cultures and different communication tools are used. Moreover, for the organization where software development management model such as CMM is being used, it is difficult to communicate and provide feedback as fast as in it does in the agile approach. In an agile development approach CMM standard is too tedious and strenuous to meet the stakeholders' requirements and response to marketing as prompt as it needs to be (Ambler, 2002).

## **1.2 Problem statement/description**

The waterfall development approach and the agile approach focus on different aspects, for example the way of working. Agile approach focuses on incremental changes that working software should be delivered frequently. The development period is from several days to a couple of weeks, with a preference to the shorter time scale (Ambler, 2002). The waterfall development approach delivers at the end of the whole software development lifecycle (SDLC). It is based on the assumption that there is almost no change of the customer requirements. This assumption is not feasible in most projects. When the customer's requirements change, the project team is supposed to be flexible and to transfer the information to them on time (Janes and Succi, 2012). However, common communication tools are used in waterfall development approach for regular information transfer and discussion in most situations (Ambler, 2002). And it takes some time to deliver the information of change. This research illustrates the difficulties of migration in three aspects, which are development environment, people factors and communication.

The problem concerns how to optimize the development process from project planning to project closure. It is in order to overcome the difficulties when migrating and as a result getting better project management performance.

### **1.3 Purpose/Aim**

The waterfall development approach and agile approach both have advantages in software development. But when the migration is in progress, conflicts and difficulties may turn up. For example how to change the development environment, how to make team members change responsibilities or how to adjust the team to different communication tools.

The purpose of this research is to provide suggestions for how to support migration from a waterfall development approach to agile approach. What the team using waterfall development approach needs to adjust is researched in this thesis. And developing processes which allow better project performance and corporate synergies to use agile development approach is researched as well. How to balance structuralism and flexibility have been considered, in order to make development processes less heavy but not lacking of discipline.

### **1.4 Research questions**

The research question is how to overcome the difficulties in implementing migration from a waterfall development approach based on CMM to an agile approach.

The research focuses on how to handle the difficulties mentioned above through process development suggestions. These suggestions are in order to make the migration smoother. They can be applied in all organizations including large, global and mixed culture organizations. For the purpose of answering this question, the following two points have to be clarified. The first one is the differences between the waterfall development approach based on CMM and agile approach, including comparison between main features of the two approaches. The second one is the difficulties in migration. These difficulties are discussed from three perspectives, which are software development environment, people factors and communication management.

## 1.5 Thesis structure

The thesis is divided into several parts, which is illustrated by Figure 1.1. Firstly, the literature review in which the knowledge of waterfall development approach and agile approach are implemented. Then the main differences between the two approaches and difficulties of migration have been drawn into conclusions by analyzing the findings from both literature and interviews. These two aspects are the main resource to define the questions for the interviews. The focus of the interviews is to identify the difficulties in migrating from waterfall development approach to agile approach and how to overcome them in the interviewed companies. The number of interviews performed is limited because a qualitative research method is used for data collection instead of a quantitative method. Nevertheless, the interviewees represent different companies and with experiences from different management levels to implement agile development approach. The result from the interviews and also one case study from literature are analyzed. Finally, some suggestions are given on the most important factors to consider for a company when planning migration. All these steps above are to benefit the last step of achieving the final goal of this research, which is getting better project performance.

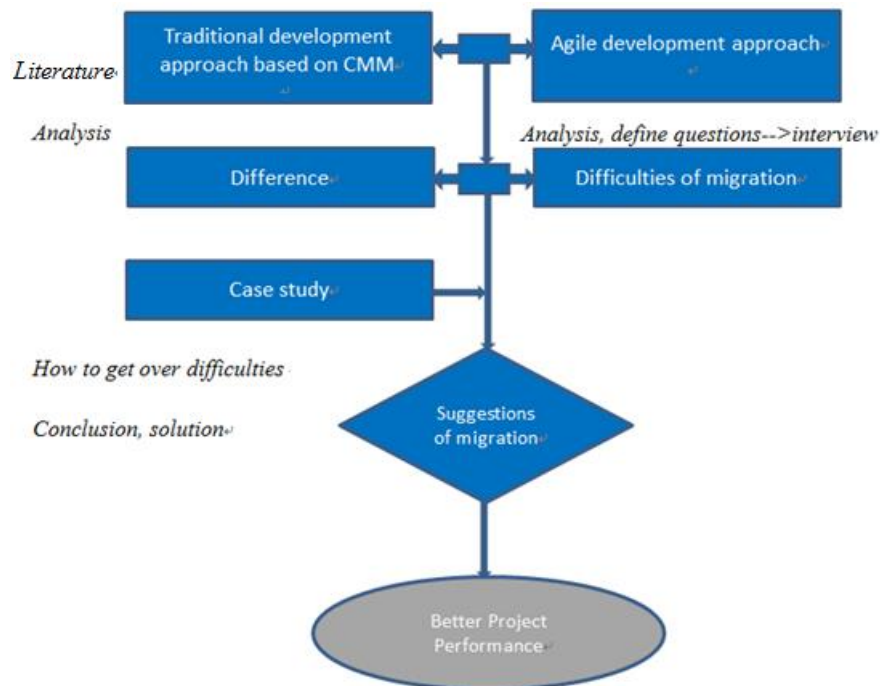


Figure 1.1 Thesis Structure

This research has taken six months, using the approach Plan, Design, Check, Act (PDCA). It starts from the feasibility and preparation phase which includes topic selection and approval of the thesis proposal. Then the design phase focuses on knowledge preparation and verification of some critical questions. The next step is to Do and Check tasks which are called the implementation phase and the commission phase. These two phases are for the main body of the whole thesis. The last phase is the optimization of this thesis report. A time schedule is presented in a Gant Chart in Appendix A.

### **1.6 Rational and implication**

This research can be used as a reference to the following aspects.

- Explaining what is needed to be done when implementing migration from the waterfall development approach to agile approach in software development.
- Increasing recognition of what should be paid attention to during the process of migration for a software development organization.
- Improving the understanding of critical aspects in migration and making migration easier for software development project managers and team members.

## 2 Literature review

This chapter presents a review of the literature underpinning this research. Figure 2.1 below shows the structure of this chapter. It starts with the illustration of waterfall development approach and agile approach. They are the brief explanations of each approach, main features in the aspects of documentation, SDLC and ways of thinking. Then a comparison has been made of the differences between the two approaches, followed by the difficulties in migration. Process management, communication management, leading a team work and how to overcome difficulties are also discussed. The chapter ends by the implementation of migration in one case study from Donald (2003).

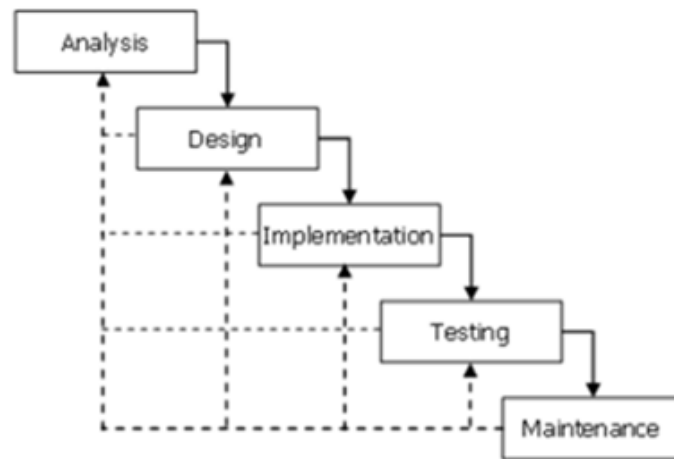


Figure 2.1 Chapter Structure

### 2.1 Waterfall approach

#### 2.1.1 What is waterfall approach?

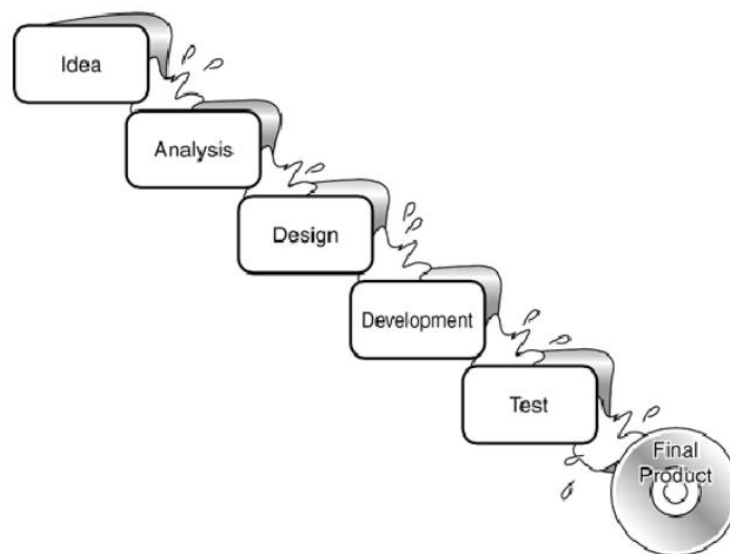
Waterfall model was proposed in 1970 (Bassil, 2012). It is a sequential design process and commonly used in software development. Waterfall development process is shown as if flowing steadily downwards like a waterfall. It is the reason why it is called waterfall development approach. According to Phatak (2012), this approach comprises five phases to be completed sequentially in order to develop a software solution. The phases are analysis, design, implementation, testing and maintenance (Phatak, 2012), which is shown in Figure 2.2. In this sequentially structured approach, the development team goes ahead to the next stage of software development; only after the previous stage is fully accomplished (Phatak, 2012).



(Bassil, 2012, p.3)

**Figure 2.2 the Waterfall Model 1**

There is no unified standard to classify the quantity of phases. For example, according to Gong (2011), waterfall approach is explained as comprising six phases to be completed sequentially. They are idea, analysis, design, development, testing and close (Gong, 2011), as Figure 2.3 shows.



(Gong, 2011)

**Figure 2.3 the Waterfall Model 2**

Compared with five phase's division theory, the only difference is whether the idea phase is classified into one separated phase or not. In some organizations, the idea phase belongs to the marketing period which provides the requirements from customers (Gong, 2011). This means that the idea phase is considered to be the

part of analysis phase in some organizations. However, both arguments assent that waterfall approach develops sequentially and the development team goes ahead to the next stage of development only after the previous stage is fully accomplished.

### 2.1.2 What is CMM?

CMM is a conceptual framework that represents process management of software development and gives a guideline on how to improve maturity for a software process (Raynus, 1999). The five maturity levels are as follows:

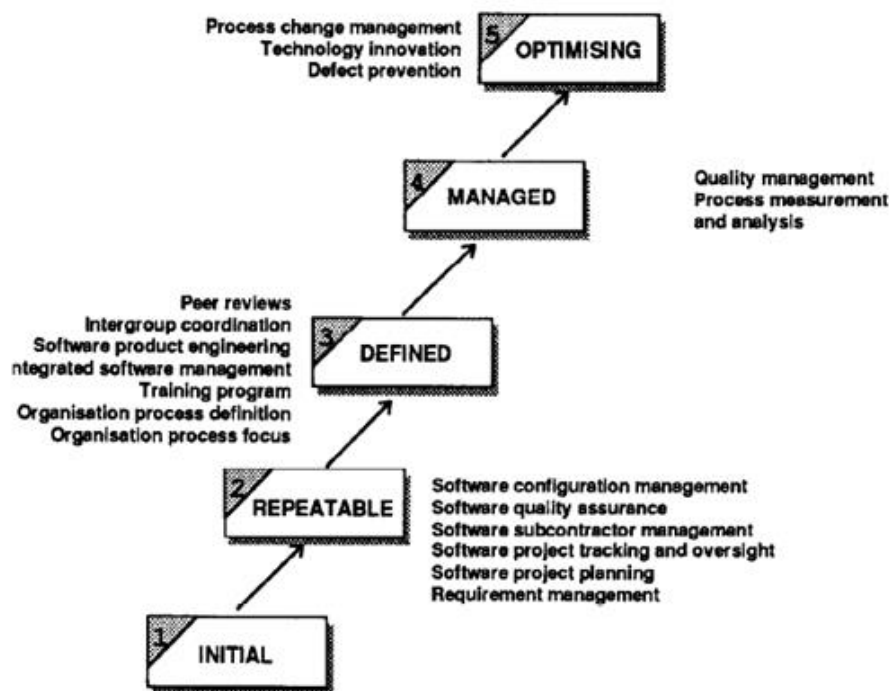


Fig. 3. The maturity levels and the related key process areas.

(Bicego and Kuvaja, 1996, p.164)

Figure 2.4 CMM Model

Level 1, initial: The software process is characterized as ad hoc, chaotic, and heroic. There are few processes defined or followed, and project success depends on individual effort. At the same time there is no formal management control over software development (Bicego and Kuvaja, 1996).



Level 2, repeatable: This level provides an introduction to the formal, documented process. Basic management processes are established which in order to control cost, scheduling, and functionality (Bicego and Kuvaja, 1996).

Level 3, defined: This level offers a basis for continuous process improvement. The software process is documented, standardized and integrated into a standard software process. Roles and responsibilities in software development start to be clear in process area (Bicego and Kuvaja, 1996).

Level 4, managed: Detailed measures of the software process and product quality are collected in this level. Both the software process and products are quantitatively understood and controlled (Bicego and Kuvaja, 1996).

Level 5, optimized: This level provides continuous process improvement which enabled by quantitative feedback and piloting innovative ideas and technologies (Bicego and Kuvaja, 1996).

The Software Engineering Institute's CMM is selected in some organizations as a model for software process improvement. Software process improvement based on CMM is believed to bring both tangible and intangible benefits to an organization (Hyde and Wilson, 2004). CMM standard is taken as a universally used maturity model in software development. It represents a development structure for self-improvement (Donald, 2003). Development processes based on CMM model aim to have strict process assurance and deliver the expected achievement. In the waterfall development approach, there are strategies to track and follow tasks in every step according to the requirements of CMM model. The strategies make sure that the development works in the way which has been defined at the beginning. All these contribute to software development to be well defined with strict process implementation and delivery step by step.

As the maturity level increases, more software development processes are adopted. As a result, it makes better assurance for working in the way which has been delimited. On the other hand, the higher maturity level the process has, the less possibility of change is supposed to arise. But it does not mean that it is more difficult to change. In fact, the higher maturity level achieved, the better strategy is adopted to manage changes.

### **2.1.3 Some waterfall approach features**

- **SDLC**

SDLC is divided into five phases by Bassil (2012) as mentioned: analysis, design, implementation, testing and maintenance. These phases are executed by turns and the next step starts after the previous step is finished. SDLC lasts from several months to several years, depending on how large the project is and how much detail is put into the project (Ambler, 2002). Every step is progressed in the same way in projects after projects, using the structure that has been set up. Each project has a long term plan and its processes are monitored. These mentioned above contribute to make sure that software development goes in the way that it is supposed to and the result is built up step by step.

- **Disciplined process and documentation**

Many organizations which are using this approach have well-defined software processes in place and the processes are followed for years. In compliance with CMM standard, these processes are prescriptive and very well documented (Ambler, 2002). In each maturity level except level 1, there are a series of processes and documentation in order to make sure all corresponding requirements of this level are met.

- **Requirement management characteristic**

As mentioned previously, there are sequences of phases that are supposed to be followed and finalized in the waterfall development approach. These steps can be recursive and are repeated again and again until all the requirements of Key Performance Indicators (KPI) are fulfilled. In the analysis phase, software requirements specification is completed entirely and defined (Bassil, 2012). When there is a new change happening during any step after analysis phase, all new

change requirements will be recorded as changes. Furthermore, according to CMM standard, all the documentation relating to this change should be modified as well. For example, if there is a new requirement to change some lines of code in one module, a documented change request should be submitted. As a consequence, the documentation of specification of requirement analysis, software design specification, software requirements specification, detailed design document should be modified because of this change. Moreover, these modifications are tracked and audited to make sure this change has been incorporated into all related steps.

- Roles and responsibility

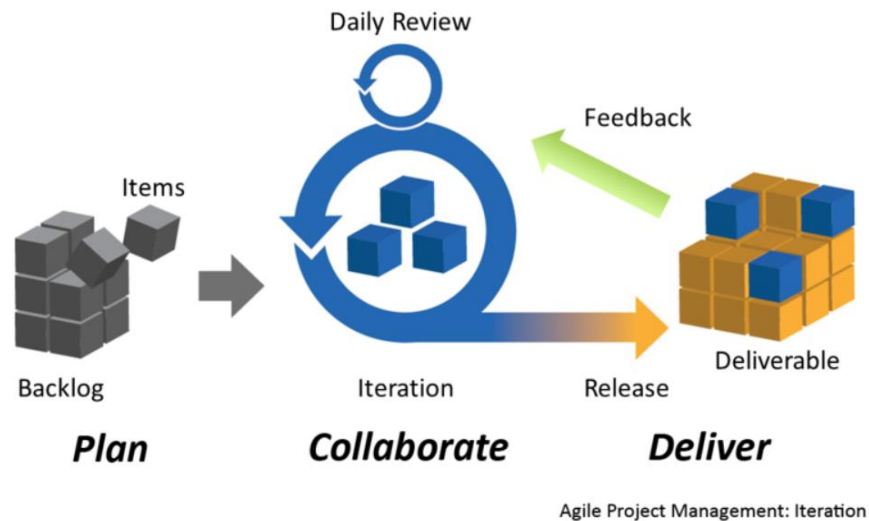
In organizations which adopt the waterfall development approach, they may go to the extreme by setting up departments. Examples of departments are as follows: marketing department which defines and negotiates requirements with customers, development department which is in charge of coding and testing, quality assurance department which is responsible for making sure the process and schedule are preceded in the defined way, and technical support department which provides technique supports (Bassil, 2012). Each department is run by a team. The team is comprised by a project manager and team members (Bassil, 2012). Team members are implementers of tasks. Project manager is the coach and leader of the team and assigns resources including people, equipment, time, effort and financial aspects (Bassil, 2012). Project manager is supposed to know in depth techniques and knowledge regarding to the project. Bassil (2012) proposes that the project manager is responsible for all the activities to the whole project during the SDCL, from beginning to closeout.

## **2.2 Agile approach**

### **2.2.1 What is Agile approach?**

“Agile methodologies including eXtreme Programming (XP), Crystal, Scrum, and feature-driven development provide techniques for delivering customer value on software development projects while creating agility through rapid iterative and incremental delivery, flexibility, and a focus on working code” (Augustine, 2005, p.21).

As shown in Figure 2.5, agile software development focuses on delivering a rapid result. A large backlog is divided into small design-build-test cycles iterations. During every iteration, the progress is checked every day during a quick meeting. The meeting is called a Stand Up. In a Stand Up, accomplishments before, goals today and blockers are discussed. When one iteration is released, feedback is used and built into the next iteration.



(Planbox, 2012)

Figure 2.5 Agile Model

## 2.2.2 Some Agile approach features

- Agile way of thinking

The agile approach ambition is not to overbuild software. Software is built as simply as possible and only when it is actually needed. Simple tools are used and the simplest model is created to implement software development (Ambler, 2002).

- Incremental change and development period

A big change can be implemented as a series of small, incremental changes. An important concept in understanding the agile approach is that the team does not need to get everything right the first time. The whole software development is divided into several iterations. Each iteration takes a couple of days to a couple of weeks (Ambler, 2002).

- No extraneous process and documentation

The primary goal of software development is to produce high-quality software that meets the needs of project stakeholders. It does not aim at producing documentation or the models themselves (Ambler, 2002). Heavy documentation which is required to fulfill the CMM standards is against the principles of agile software development. Ambler (2002) argues that production of heavy documentation is a time consuming activity which delays the increments and ultimately delays the whole project release. In the agile approach, process and documentation are decreased and only adopted when they are needed. It aims at achieving project goals without extraneous process and documentation.

- Fast feedback

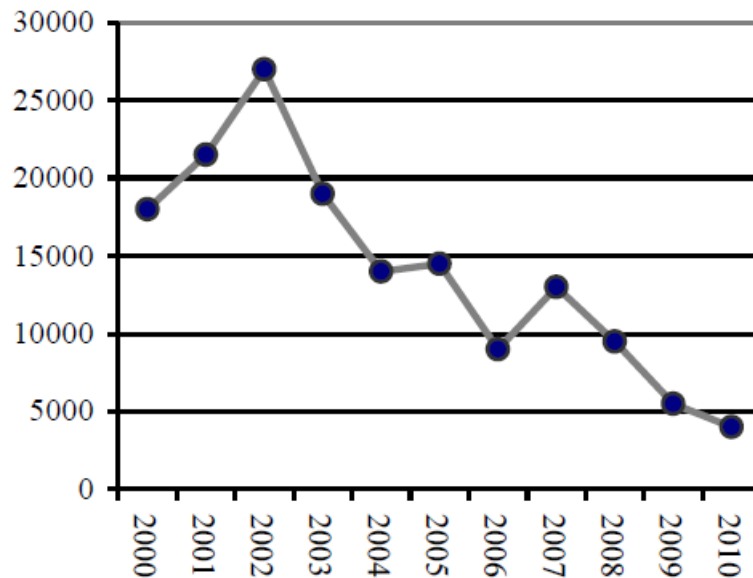
For agile software development, feedback from previous iteration is built into the next iteration once the previous one is released. This fast feedback is helpful to identify mistakes. Since agile development phase is implemented in short term iterations, mistakes can be found in anterior iterations in the development (Ambler, 2002). When delivery of the first iteration is tested, the issue in this iteration can be found and fixed before release. Then this issue will not affect the later iterations and has less probability to turn into a more complicated one which costs more effort to fix. As a result, the earlier of issues to be found, the less risk for the production and cost to fix them.

### **2.2.3 Negative sides and misconceptions of Agile approach**

As discussed above, agile approach is considered to have less documentation, change easier and deliver faster. If an organization thinks that agile approach is more efficient and produces value more timely, they may adopt the agile approach. But in fact those features are not comprehensive to decide whether agile approach should be adopted or not. There are some misconceptions of agile approach which may bring the organization in difficulties and distortion in the implementation.

Firstly, agile approach is considered as a solution to every problem. However, according to data from Yahoo website for one agile method of extreme programming (Janes and Succi, 2012). “Agile Methods passed the peak of inflated

expectations, the hype is over. The attention to the topic Agile has reduced. Agile is not anymore considered the solution for everything” (Janes and Succi, 2012, p.217).



**Figure 3.** Number of messages posted on the “extremeprogramming” Yahoo! discussion group as of January 6, 2011

(Janes and Succi, 2012, p.217)

**Figure 2.6** Number of Messages Posted on the “extreme programming”

With all the popularity that agile approach has gained, the precise boundary of its applicability is not been entirely understood, which shows that agile approach is still not considered as a standard like CMM, International Standardization Organization (ISO) 9000 or the other ones.

Secondly, many software developers think the work is casual in agile approach. They think individuals and interactions are used, instead of processes and communication tools (Janes and Succi, 2012). For example, team members just talk when cooperating with each other and do not use a standard process. They implement customer collaboration orally without contract negotiation. It is easier and more convenient to collaborate without contract. However, the contract is still useful when avoiding conflict and it is a useful record to illustrate

misunderstanding caused by communication. Agile process is flexible but not casual. The flexible way lies in that the process can be changed by proceeding developments to smaller requirements.

Thirdly, many team members think that no (or less) effort is needed to put on documentation because cutting down overhead documentation is encouraged in agile approach (Janes and Succi, 2012). Compared with traditional development approach in which a quantity of documentation is generated, a lot of knowledge is tacit and resides in the heads of the agile team members (Highsmith, 2003). As a consequence, sharing and recording knowledge are vital for summarizing this project and are beneficial for future projects. For process development aspect, making some strategies to encourage sharing and recording knowledge inside the team is necessary (Highsmith, 2003).

Last but not least, some team members think that the change has higher priority than project plan in agile approach. When a change is happening, the team focuses on this change and put the project plan to be implemented after this change. However, project plan plays as navigation for the project and leads to project final delivery. Following a plan makes the team think about the problems and how they might actually be solved. And the team has to work out the main project goals in each phase (Janes and Succi, 2012).

### **2.3 Differences between the two approaches**

According to literature review, the main differences which also influence the migration between waterfall development approach and agile approach are listed as Table 1. The items in the table are discussed in detail, which belong to three aspects: development of environment, requirements towards change and people, and cost of change.

	Waterfall	Agile
Way of thinking	Plan-driven	Outcome-driven
Lifecycle	Phase by phase	Incremental changes
Process	Well-define, delivery in every step, do it right the first time	Allow go back to previous step
Documentation	A series of documentation in every step	No extraneous, less focus on documentation
Developers	Adequate skills, access to external knowledge	Knowledgeable, collocated, and collaborative
Team size	Larger teams	Smaller teams
Product architecture	Designed for current and foreseeable requirements	Designed for current requirements
Requirements	Mainly stable, knowable early	Rapid change, largely emergent
Cost of change curve	Increase acute after coding	Stably increase

(Cockburn and Highsmith, 2001)

**Table 2.1 Differences between the Two Approaches**

### **2.3.1 Development of environment**

- Way of thinking and lifecycle

Waterfall development approach based on CMM is a type of plan-driven development method which is focused on plan implementation. It follows project plan in every development phase. Changes are not welcomed after the customer requirements are defined. This approach implements sequentially and uses CMM model to manage all the phases during the SDLC. It results in good performance for long-term software development (Cockburn and Highsmith, 2001).

Agile approach is outcome-driven method. It centers on delivery and gives small delivery in every iteration. This approach focuses on incremental changes that the development team delivers working software frequently, from several days to a couple of weeks, with a preference to the shorter time scale (Cockburn and Highsmith, 2001).

- Process and documentation

In waterfall development approach based on CMM, processes are well defined and there is a series of documentation. The processes aim at providing assurance to



make sure the project works in the defined way. The documentation is to meet CMM standard requirements and beneficial for future projects. The output of a previous step is the input for the next step and cannot go back to the previous steps. The final delivery is achieved in last step. That means the team needs to get everything right the first time (Ambler, 2002).

Agile approach focuses on less effort towards processes and documentation. This approach has not extraneous processes and documentation (Cockburn and Highsmith, 2001). When a requirement is not met or a problem is not fixed in one iteration, it is put into the other iteration to finish. As a result, it is possible for agile approach to get back to the previous iteration or jump to another iteration.

- Product architecture

The product architecture of waterfall development approach based on CMM is designed for current and foreseeable requirements. The main requirements are known at the beginning of the software design and expected to be mainly stable because changes will mean increased cost and efforts (Cockburn and Highsmith, 2001).

Agile approach is designed for current requirements and it is largely emergent and prone to rapid change (Augustine, 2005). If the requirements in one iteration have not been completely resolved, the rest requirements are put into other iterations to continue.

### **2.3.2 Requirements**

- Towards change

Waterfall development approach based on CMM is founded on the assumption that there is almost no change of requirement. When a requirement changes, the project team is supposed to be flexible enough to fix them (Janes and Succi, 2012).

Agile approach provides a new perspective to software development that has a remarkable focus on agility. Ability is for adapting to change of requirement or environment and generate more value to customer (Cockburn and Highsmith, 2001). It is to increase the ability to change things not only in the beginning but also in the late development process and as a result generate value throughout the whole process.

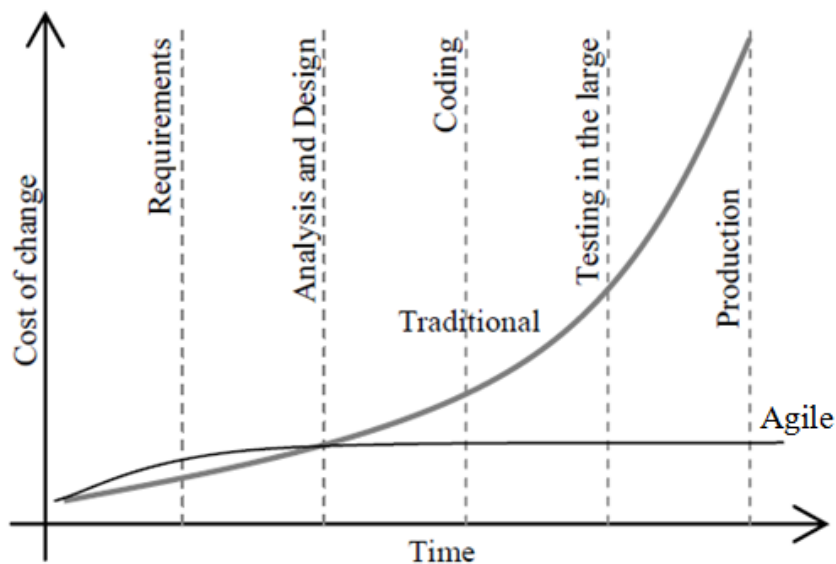
- Towards people

Waterfall development approach works well in larger teams. It is easy to get external knowledge support (Cockburn and Highsmith, 2001).

Agile approach is fit for small teams. In an agile team, everyone needs to share knowledge and be collaborative (Cockburn and Highsmith, 2001).

### 2.3.3 Cost of change

According to research data from Janes and Succi (2012), the cost of change in the two approaches is shown in Figure 2.7.



(Janes and Succi, 2012, p.216)

Figure 2.7 Traditional and Agile Cost of Change Curve

In waterfall development approach, cost of change increases in a stable way until analysis and design phases (Janes and Succi, 2012). But as discussed above, when a change happens after that, it costs a lot of effort to fix and make sure that all related area such as code and documentation are modified accordingly.

In the agile approach, cost of change is stable all through SDLC. In this approach, upfront planning and definition of customer requirements are given up until they are needed (Janes and Succi, 2012). For such definition, cost is similar in all the development phases. This also lowers the cost of the modification (Janes and Succi, 2012).

## **2.4 Difficulties in migration**

Difficulties in migration from waterfall development approach based on CMM to Agile approach are varying from different organization and specific situations. According to literature review, there are three main difficulties in migration: changing development model, people factors and communication barriers.

### **2.4.1 Changing development model**

Migration means to change the process model from a plan-driven, life cycle model to one that is based on outcome-driven, development of evolutionary and iteration. Such a change involves working processes, tools and techniques, communication methods, problem-solving strategies and responsibilities of team members (Nerur et al., 2005). Especially for the team who are used to the working style of waterfall development approach based on CMM, migration to agile approach means changing the way of working in most areas. In general, it takes some time for team members to get used to the new development method.

### **2.4.2 People factors**

Boehm and Turner (2005) think that “people issues are the heart of the Agile movement, and much of the paradigm change is aimed at empowering individuals by supporting reasonable goals, shorter feedback cycles, ownership, and flexibility” (Boehm and Turner, 2005, p.36). Management attitude of project managers in agile approach is different compared with in the waterfall

development approach. As for migration, project managers are needed to associate employees with specific roles and responsibilities. That might cause difficulties in the multi-tasking characteristics of agile team members. Project managers in agile approach play two primary roles: protector and coach (Boehm and Turner, 2005). In the waterfall development approach, project managers have more power to make decisions and strategies than in agile approach. As a consequence, hierarchy is more strict in the waterfall development approach. Lots of team members are used to follow managers' decisions without many personal opinions. In addition team members especially for those who are used to the waterfall development processes may not be fully conscious of the agile approach. And they may have difficulties in admitting that a practices-based method can also be as effective as a prescriptive method (Boehm and Turner, 2005).

In the waterfall development approach, it is easy to get external knowledge support (Cockburn and Highsmith, 2001). Agile approach is focused on collaboration and communication strongly. It needs everyone to share knowledge and be collaborative (Smite et al. 2002). As a consequence, when migration is in progress, there are more technical requirements for team members. So whether team members themselves are technical enough is more important in agile approach than in waterfall development approach. It turns out that technique level of team members is a challenge for migration (Cockburn and Highsmith, 2001).

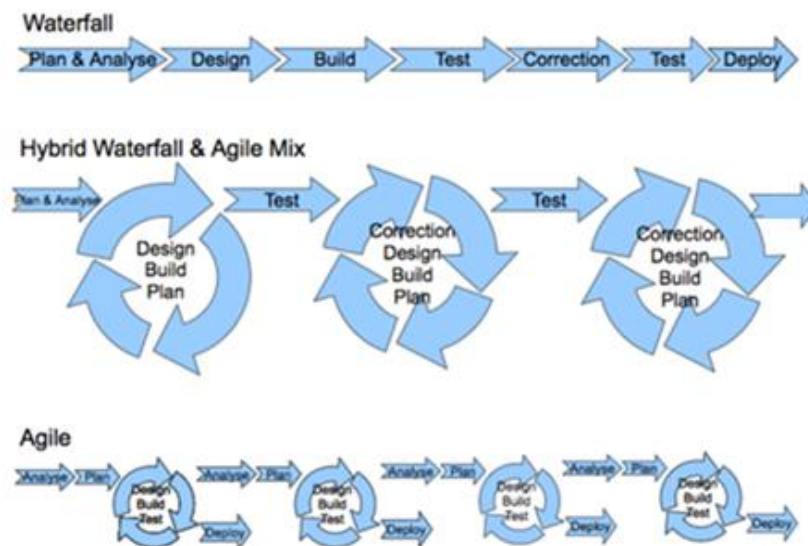
### **2.4.3 Communication barriers**

Another apparent difficulty is communication barrier (Cockburn and Highsmith, 2001). As mentioned above, agile approach needs efficient communication with rapid feedback. For this reason, more strict communication rules are needed for agile approach, compared with waterfall development approach. This could be a difficulty that need be overcome because communication is implemented frequently and is an important way to make decisions. Barriers such as technical skills, time zone and culture differences can become difficulties when migration is implemented (Nerur et al., 2005). Especially for global organizations, "the agile approach can be implemented on large or distributed teams, but communication challenges quickly get in the way" (Ambler, 2002, p.37).

## 2.5 Hybrid approach

According to Gong (2011), the waterfall development approach is comprised of six phases which are idea, analysis, design, development, testing and close. If testing phases is detailed to correction after test and then test again, it experiences Plan & Analyze, Design, Build, Test, Correction, Test and Deploy phases. In contrast, agile approach focuses on iteration development. It experiences Analyze, Plan, Design, Build, Test and Deploy phases (Gong 2011). It repeats the life cycle for all the iterations.

In 2010, Savaged raised one approach which is called hybrid of waterfall approach and agile approach mix. It has SDLC as waterfall development approach but at the same time, each phase is divided into small iterations, as Figure 2.8 shows.



(Savaged, 2010)

Figure 2.8 Approaches Description

## 2.6 Process development

### 2.6.1 What is project management?

The project's main characteristics are that it is temporary, unique, aim-focused, high variety and uncertainty, having time and cost constraints which include resources and external circumstances (Maylor, 2010).

Project management is no longer only related to manage the sequence of steps to be completed on time. Furthermore, project management focuses on customer satisfaction, creating a disciplined way of prioritizing effort and addressing all the perspectives in multiple function teams (Maylor, 2010).

### **2.6.2 What is process development?**

At the beginning, software process development was to write down all the steps. People developed flowchart diagrams and at the same time pages upon pages of process documentation was generated (Captuto, 1998). However, today this work involves greater creativity, participation, and collaboration in order to get better performance in stakeholders' satisfaction and more value from the project.

### **2.6.3 How process management influences on projects?**

A lot of software organizations at present are endeavoring to improve their software development processes in order to improve product quality, project team productivity and reduce the development cycle period to increase the competitiveness and profitability (Captuto, 1998).

Software process improvement is a general definition, the specifics of which are addressed in CMM (Hyde and Wilson, 2004). Three main aspects which are related to software process improvement are cost, scheduling, and quality (Raynus, 1999).

## **2.7 Communication management**

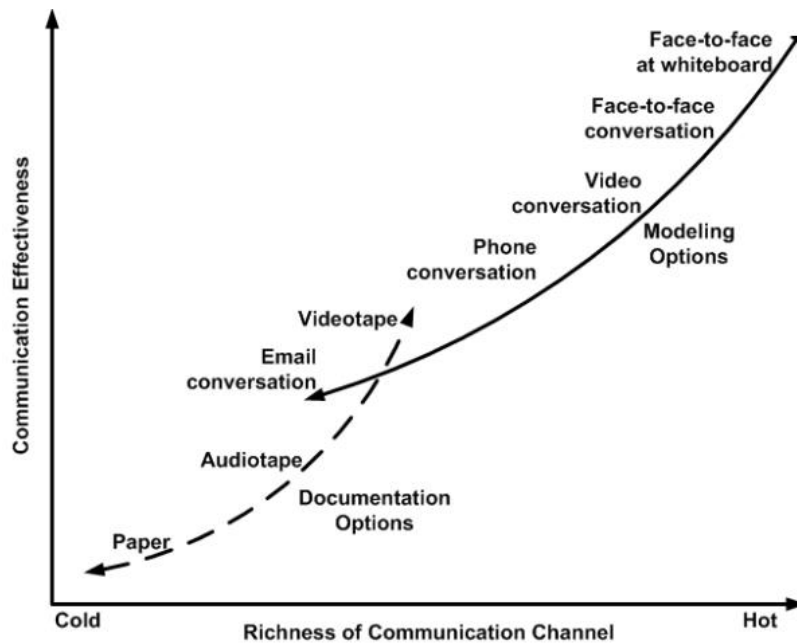
### **2.7.1 What is communication management?**

“The first purpose is to acquire the right information and send it to the right people in the right form at the right time... the second purpose is to ensure that the communication process occurs and sustains itself throughout the life of a project” (Kliem, 2008, p.72).

“Good communication is the key to successful project management” (Michalski, 2000, p.84).

### 2.7.2 Communication channels

According to Ambler (2002), the widely used communication channels and the corresponding effectiveness are shown in Figure 2.9.



(Ambler, 2002, p.84)

Figure 2.9 Communication Channel and Corresponding Effectiveness

The more senses there are, the higher efficiency is. Simple tools such as whiteboards, sticky notes, flip charts, and index cards are commonly used and are easy to work with. These tools can make communication more flexible, easier to be used and have high efficiency (Cockburn and Highsmith, 2001).

### 2.7.3 Key factors and advice

Following elements are considered important to be effective communication management by Michalski (2000).

- A solid communication plan. It includes time, frequency, and attendance etc. According to Michalski (2000), poor communication has two causes which are unclear expectations and confusion of whom to reach for information. The

solution to resolve this problem is using a communication plan. It helps avoiding difficulties caused by unscheduled changes in a project. The communication plan ensures that communication remains open and timely. As a result, the project team get informed on changes timely and are not hit with surprising news.

- Communication regularity. It guarantees communication is held on time and disciplined. Communication regularity depends on the specific situation of the project process. When the milestone is coming or sharply increased unexpected changes turn up, communication regularity is adjusted to meet the different situation.
- Communication contact. Attendance is exactly related to the meeting content. And the people with high communication skills are helpful to ensure that communication occurs according to the needs of the communication plan (Maylor, 2010).

As for improving efficiency of communication management, the following advice has been given by Maylor (2010).

- Be clear about what is needed and expected from all the communication attendance at the beginning.
- Work together in order to define clearly roles, responsibilities, project goals and plans, to develop decision making strategies, and to generate and implement agreement resolution method for issues.
- Clarify the connotation of jargon which may cause confusion.
- Make strategies to track and ensure that information you send has been received.

#### **2.7.4 Main challenges**

According to Dow and Bruce (2007), the main challenges of communication management are explained as follows.

- Size

Communication links (CL) are the connections between people in communication. One CL is created when two people communicate. CL can be calculated by the



formula Number of CL =  $n(n - 1)/2$  . Here n means number of people who are involved in communication (Dow and Bruce, 2007). The more people are involved, the larger size of CL is. It turns out that more people can make communication more complicated and more channel choices exist. These can occur among the team members and create a complex networking web (Kliem, 2008).

- Complexity

When facing technical requirements, challenge goes toward communication. The more complexity of technique required in a project, the more possibility of miscommunications and the more difficult to communicate in high effective. Thus, in one team, especially for a knowledge based team, specialists maybe experience being isolated temporarily from those who have not specific professional knowledge (Kliem, 2008).

- Location

For a global organization, teams are located in variety geographical location. “It is perhaps the biggest challenge confronting an effective communications plan.” (Kliem, 2008, P73) The more people are scattered, the greater challenges for them to have regular communication and effective connection because of diverse time zones, languages and culture differences (Kliem, 2008).

- Diversity

People are different in common features such as age, race, religion, gender etc. However, as for project management, there are several important differences that can effect communication. Such as, different ways of thinking, communication technique, working custom and culture are all counted (Kliem, 2008). The same as the challenge of location, globalization can make this challenge larger and cause team members have district reflection.

## **2.8 Leading a team - effective teamwork**

In one project, one of the fundamental roles of the project manager is to co-locate individuals in order to make them a cohesive whole. Moreover, is to make sure the benefit of all stakeholders (Maylor, 2010).

### **2.8.1 What is teamwork?**

“Team work is the ability to work together toward a common vision; the ability to direct individual accomplishment toward organizational objectives. It is the fuel that allows common people to attain uncommon results. Simply stated, it is less me and more we” (National Safety Week, 1994, p.44).

Project teams are increasingly being organized not only just within one organization but also from cross organizations. Furthermore, it is often from geographically separate locations. This type of team is called a virtual team (Maylor, 2010). However, organizing one team does not mean it is a team with high efficiency teamwork which is an aspect of a successful project (Pinto, 2010).

### **2.8.2 Characteristics of effective teamwork**

In order to obtain positive contributions from a project team, eight characteristics of effective teamwork have been identified as follows.

- Have a clear and elevating goal, in which a sense of mission is generated and is understandable, significant, worthwhile and personally or collectively challenging.
- Provide a results-driven structure in the project team.
- Have competent team members who can balance personal with technical competence.
- Unify commitment which needs generating an environment of “doing what has to be done to success” (Maylor, 2010, p.249).
- Foster a collaborative climate which encourages reliance on others across teams.
- Set up standard of excellence by the use of individual standards, team pressure and recognition of failure consequences.
- Have external support and recognition.
- Have institute principle leadership.

(Maylor, 2010)

### **2.8.3 Geographically separated teams**

In general, there are some problems arising in teamwork from geographically separated teams. The obvious problems are different languages and cultures. Each team site decides their ways of working and communication tools (Maylor, 2010). Also the project priority is defined different by the location where each team placed. The priorities affect different relative importance for each project site. For example, one same project can have higher priority to be implemented from headquarters than from the other sites. Moreover, time zone and standards due to requirements of market are different in every area and are included into one of problems as well (Maylor, 2010). It is also difficult to conceptualize project tasks in geographically separated teams. Such problems may add the feeling of isolation to team members working globally; poor development and communication of plan; no clarify responsibility of belonging who and to whom and no enrich of sharing of issues. These effects are contrary to high efficiency teamwork. (Maylor, 2010)

In order to resolve or decrease the risks of these problems mentioned above, some advice as follows are helpful for a project manager in such an environment according to Maylor (2010).

- Regular face-to-face meetings and video conferences for other sites, ensuring communications are working and maintaining the team to be engaged with the project.
- Use judicious emails keeping people noted, yet at the same time make sure that only the necessary information is allowed.
- Draw up 15 to 25 percent less achievement aim to other sites compared with headquarters is realistic.
- Let team members in remote locations work with senior managers in order to clear the way for them to be supported, not only for assessment but also for rewards.

(Maylor, 2010)

## **2.9 How to overcome the difficulties?**

According to literature review, in order to make the migration from waterfall development approach to agile approach smoother, there are some strategies which aim at fixing the difficulties in development environment compliance, changing development environment, people factors and communication barriers.

### **2.9.1 Development environment compliance**

As for the migration, whether the organization is fit for agile approach should be first considered (Ambler, 2002). There are some factors of development environment which are able to judge it is difficult or not to migrate to agile approach. The closer towards these characteristics the company is; the more compliant the organization is and the easier it is to migrate. These characteristics are typical features, home ground and power distance.

- Typical features

Typical features related to migration are as follows. If one organization has not such features or at least has not potential to implement them, it will be more difficult to adopt the agile approach.

- Responding to changes quickly and efficiency.
- Customer and teams work jointly all throughout the project.
- Face-to-face meetings between development team and customer.
- Change requirement even in late phases of the system development is welcomed.
- Trust and respect among team members.
- Development process is supposed to be as simple as possible.

(Ambler, 2002)

- Home ground

Home ground areas are the category aspects of the development environment. Each home ground area can be used to contribute to determine relative risks in migration. As demonstrated by Cockburn and Highsmith (2001), if the project fits an agile home-ground profile mentioned below, the risk in migration can be

decreased by conducting stakeholder requirements negotiations among the developers and customers.

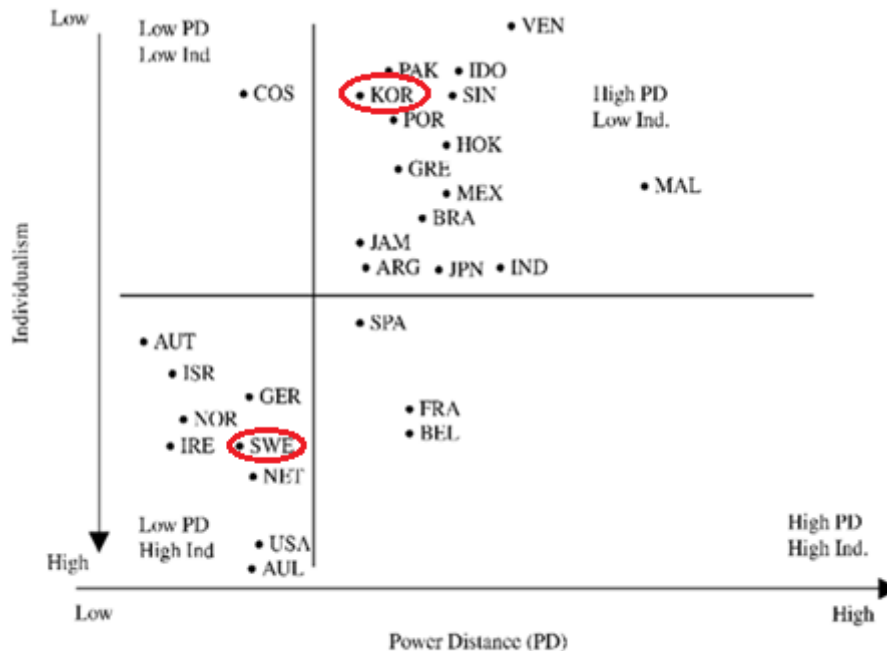
<b>Home-ground area</b>	<b>Agile methods</b>	<b>Plan-driven methods</b>
Developers	Knowledgeable, co-located, and collaborative	Plan-driven; adequate skills, access to external knowledge
Customers	Dedicated, knowledge, collocated, collaborative, representative, and empowered	Access to knowledgeable, collaborative, representative, and empowered customers
Requirements	Largely emergent; rapid change	Knowable early; largely stable
Architecture	Designed for current requirements	Designed for current and foreseeable requirements
Refactoring	Inexpensive	Expensive
Size	Smaller teams	Larger teams
Primary objective	Rapid value	High assurance

(Cockburn and Highsmith, 2001, p.68)

**Table 2.2 Home Ground for Agile and Plan-driven Methods**

- Power distance

The Figure 2.10 illustrates the research result of individualism and power distance (PD) in some countries.



Source: Adapted from Greet Hofstede (1983b)

ARG	Argentina	JAM	Jamaica
AUL	Australia	JPN	Japan
AUT	Austria	KOR	Korea
BEL	Belgium	MAL	Malaysia
BRA	Brazil	MEX	Mexico
COS	Costa Rica	NET	The Netherlands
FRA	France	NOR	Norway
GER	Germany	PAK	Pakistan
GRE	Greece	POR	Portugal
HOK	Hong Kong	SIN	Singapore
IDO	Indonesia	SWE	Sweden
IND	India	SPA	Spain
IRE	Ireland	VEN	Venezuela

(Hofstede, 1983, p.89)

**Figure 2.10 Individualism and Power Instance in Some Countries**

The larger the power distance is, the lower the individualism is, the more difficult for migration is. Take an example of Korea and Sweden; it is lower individualism and a higher power distance in Korea than in Sweden. Generally speaking, this means that it is likely to be more difficult to migrate in Korea than in Sweden according to Hofstede's theory.

### **2.9.2 Changing development environment**

There are four fundamental principles for agile development environment. Firstly, it fosters alignment and cooperation. Secondly, people are considered the primary agents who drive value, change, learning and adaptation (Augustine, 2005).

Thirdly, compared with the waterfall development approach, people are more focused on and share the vision in agile approach. Lastly, agile development environment lets people be aligned and act toward common project aims.

Changing development environment in the migration is about employing an outcome-driven, organic, change welcomed approach instead of a plan-driven, mechanistic approach that is not embracing changes (Augustine, 2005).

Development environment is supposed to get from long-term plan-driven, high management hierarchy and change resistance to iterative, self-disciplined and change welcomed. The ideal agile development environment is where between chaos and order. And there are “just enough” control, structure, optimization and exploration which are implemented only when they are needed (Augustine, 2005).

According to differences between the two approaches, conclusions can be drawn into that the approach after migration should be limited by neither too much structuralism nor free-flowing flexibility (Konrad and Over, 2005). As a consequence, balanced structuralism and free-flowing flexibility are helpful for smooth migration in order to make the development process less heavy but still not lacking discipline. The balance between cost, complexity, control and improvement should be considered. Furthermore, processes and practices should be kept as simple as possible and people are encouraged to be self-organized. Feedback is also helpful for continuous learning, adaptation and optimization.

For migration in an organization, the following questions should be considered in order to be well prepared for setting up agile development environment.

- Whether the existing process is necessary or not
- Whether the team members are used to and ready for change or not
- Whether the team members are self-organized enough or not to achieve project tasks using simple rules

- Whether the team members are satisfied and motivated by the organization enough or not to follow one common goal

(Augustine, 2005)

### **2.9.3 People factors**

The most important implication for managers in organizations that will change from the waterfall development approach to agile approach is that more emphasis is put on people factors in the project (Highsmith, 2003). The project manager who assumes responsibility for leading the agile team does need to highlight the differences with software craftsmanship. A manager leading a team of software craftsmen who are the experts in technique needs to establish an egalitarian relationship with the master craftsman and both defer to and rely on the superior technical judgment on technical matters. This does not mean that the manager should be ignorant of technology, but that the master craftsman should be allowed to heavily influence technical decisions. Additionally, the manager needs to prepare for allowing all members of the technical team to give input into decision making (Augustine, 2005).

The waterfall development approach based on CMM focuses on learning at the organizational level, and most implemented practices address the need of both team and individuals (Augustine, 2005). As for the agile approach, it focuses on customer, team and individual developers. To resolve conflicts cause of the difference, following strategies are raised.

- Make a quality plan and build targets.
- Make plans in detail for each team member for the next project phase and merge them into a team plan.
- Balance the workload in a team in order to be fair to everyone and avoid conflict between team members as much as possible.
- Assess risks and assigning responsibility for tracking tasks. At the same time, clarify responsibility is important as well because this can decrease the risk of conflicts caused by shirking between members.(Augustine, 2005)



#### **2.9.4 Communication barriers**

In agile approach, everyone's input is welcomed in project team. To be an effective teammate, everyone can learn from everyone else. People's instincts, open and honest communication are often the best policy (Ambler, 2002). There are several main strategies to be beneficial to fix communication barriers in four aspects. According to Cockburn and Highsmith (2001) and Ambler (2002), the aspects are physical proximity, temporal proximity, amicability attitude and anxiety.

- Physical proximity

"A few designers sitting together can produce a better design than each could produce alone" (Cockburn and Highsmith, 2001, p.68). The closer people are to another, the greater opportunities to have high efficient communication. There is one way for team members to have efficient communication which is sitting together to work. However, this method has limitations such as higher requirement is needed for team members' maturity. If no senior, experienced person is in the team, it is probable that a design by committee mess is generated, which is a chaos atmosphere for making decisions and get agreement (Ambler, 2002).

- Temporal proximity

Whether the team members are working at the same time or not, that is, whether the team has different time zone or flexible schedule affects communication. Team members are located in different time zones in international organizations. The solution is adopting more communication tools which less depend on geographical location such as emails. Video meeting and phone meeting can also be used in overlap working hours for communication (Cockburn and Highsmith, 2001).

- Amicability attitude during communication

The greater the amicability, the more information can be shared with team members and the less information is concealed (Cockburn and Highsmith, 2001). It is related to communication atmosphere in development environment. So strategies of encouraging amicability communication environment can be used.

- Anxiety

Anxiety exists for individuals about certain types of communication. Some team members prefer to discuss issues on the phone, others like to write on the board. Some people tend to use emails; on the other hand others think emails easily cause misunderstanding. Simple tools like emails, whiteboard are commonly used because there is little opportunity for embarrassment by revealing team members are not adept with the simple communication tools. More complicated tools often prove to be barriers to communication (Cockburn and Highsmith, 2001). When people collaborate and corporation in one team, tools should be found that most team members are comfortable with or at least can learn to tolerate for the duration (Ambler, 2002).

## **2.10 One case study from literature**

One case named XP and the CMM from Donald (2003) is studied and analyzed. The difficulties in this case reflect the typical difficulties in migration from waterfall development approach to agile approach. The case was used as input when the questions of interviews were defined for how the difficulties are overcome and what the migration implementations looked like in some companies.

In the case, project team members resisted using processes that were set up by process group because they thought that the processes were too formal and too many documents involved (Donald, 2003). The developers mainly modified processes of testing to address XP practices to large projects. Independent test teams verified delivery by weekly builds, which led changes to the XP test-first practice and generated additional test documentation. This method caused no complaint from the test team. On the other hand XP practice generated fewer documents than when using CMM standard, which caused dissatisfaction from the quality assurance (QA) team. The XP manager kicked QA team because the manager thought QA team had not added value to the project (Donald, 2003). This behavior made the QA team on the warpath. At the same time, test team and QA team pointed to each other and formed camps (Donald, 2003). As a result, people

were waiting for the open issues to be resolved instead of fixing issues. Conflict turned up between the developer team and process team (Donald, 2003).

The conflicts in this case verified the three main difficulties mentioned above. The team was not used to the new approach at the beginning. Conflict between people was most obvious and communication skills were needed. The developers chose XP methods because it was supposed to meet the schedule. But if the firm relied on past processes that would take long time to put the applications on their portal. The developer team thought that they did not have time for the formality expected when following processes in plan-driven approaches. On the other hand, process team argued they needed time to guarantee good quality and customer's satisfaction. The case showed that documents had been modified a lot during migration. And the project manager had a major priority to kick the QA team off the agile project in this organization.

As for fixing the problems, they could have modified QA processes to play a more valuable role, especially to make sure adherence to the additional testing practices that XP approach added. Rewrite process manuals to meet the new approach and provide process support, such as comparing the differences between the two approaches to make it easier to be accepted by software developers (Donald, 2003).

## 3 Methodology

The main purpose of this chapter is to illustrate which methodologies are used in this research. The chapter is divided into three parts which are research structure, research scope and limitation, and ethical considerations.

Research structure is divided into three parts which is shown by Figure 3.1. They are pre-production, production and post-production. Pre-production part is for research idea and design which explain how this research is motivated and organized. Production part focuses on how research results are drawn into conclusions, how to do literature review and how to collect data for interviews. Post-production part aims at showing how to make data analysis and publication.



(Research Process, 2012)

Figure 3.1 Research Structure

### 3.1 Research question

The research question is how to overcome the difficulties in implementing migration from a waterfall development approach based on CMM to an agile approach.

### 3.2 Pre-production

#### 3.2.1 Research idea

The research idea refers to picking a topic and translating the topic into a research question (Research Process, 2012). The motivation for research may be either one or more of the items which are listed below.

- Desire to get a research benefits
- Desire to take the challenge in solving problems existing
- Desire to get satisfaction of doing creative work
- Desire to service for society
- Desire to take respectability

(Kothari, 2004)

This research topic was generated by the first two reasons and motivated by the situation at present in the industry which the research lays on, working experience and related literature review.

### 3.2.2 Research design phase

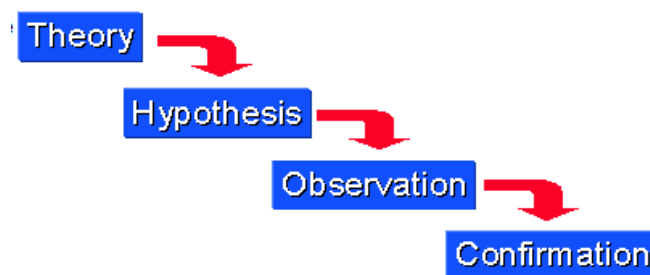
Research design phase focuses on selecting the methodological approach, craft procedure and evaluates the practicality of this research and so on (Research Process, 2012).

- Research approach

Research approach includes deductive reasoning and inductive reasoning.

#### ➤ Deductive reasoning

Deductive reasoning is working from general to specific. As the Figure 3.2 shows, this method starts from a theory of research topic, then narrows it into hypotheses which can be tested. Next is using observations that are related to the research question to address the hypothesis. This ultimately leads to testing the hypotheses with data which is called confirmation of original theories (Trochim, 2006).

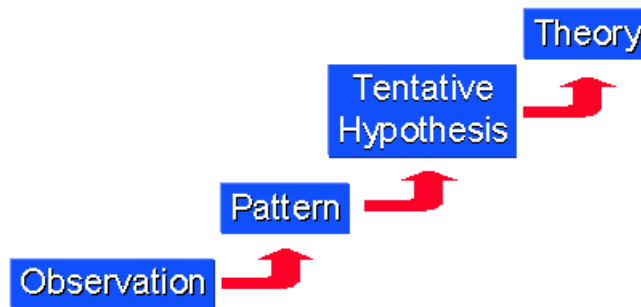


(Trochim, 2006)

**Figure 3.2 Deductive Reasoning**

➤ Inductive reasoning

Inductive reasoning which is illustrated by Figure 3.3 works in the opposite way compared with deductive reasoning approach. It begins with specific observation to broader implementation and theory (Trochim, 2006). After that, pattern begins and hypotheses are explored and researched. At last, general conclusions or theories are developed.



(Trochim, 2006)

**Figure 3.3 Inductive Reasoning**

Deductive reasoning is adopted in this research. It is from theory review, data analysis, then getting the solution of research question. At last it confirms theories which are related to this research.

### **3.3 Production phase**

Production phase is mainly about getting proposal approval from universities, preparing to conduct research, clarify how to do literature review, implement interviews and data collection (Research Process, 2012).

This research is designed to be implemented in three steps in order to assure credibility of the findings and enrich the analysis. The first step is the literature review which considers similar situations and can be considered as a basis guideline for questionnaires. Furthermore, differences between waterfall development approach and agile approach are found out and main challenges are listed. At the same time, questionnaire is generated. The second one is interviewing, which is about using the defined questionnaire and analyzing the

results in order to find the implementations in the interviewed companies. The last step is drawing into conclusions for the research and giving suggestions to resolve the research question.

### **3.3.1 Literature review**

There are a quantity of books, articles, journeys and case studies which are related to migration from a waterfall development approach to an agile approach in different aspects. For this research the literature includes books and articles. All the books are from Chalmers Technology of University Library and textbooks of master study in Chalmers Technology of University. Articles are from Chalmers Technology of University Internet Library, Northumbria University Internet Library and Google Scholar. The literature which is used for this research is listed in References chapter. Some other articles are also studied but have not been quoted in this research and, they are sorted out in Bibliography chapter.

A broad range of literature studies and data collected from interviews are important for studying the topic and analyzing the research question. From the books, following topics are studied in order to understand the basic knowledge of the two approaches, project management and migration.

- Waterfall development approach versus agile approach
- Negative sides and misconceptions of agile approach
- Factors to determine whether it is difficult to adopt agile approach
- Influence of CMM, process management on project management
- Communication management
- Leading a team

Then from the articles and the references for these books and articles, topics listed below have been summarized and discussed.

- Difficulties in migration
- Case study from literature
- How to overcome difficulties

As a result, solutions for this research question from the theoretical aspect are gained after literature review.

### **3.3.2 Data collection**

There are two approaches for data collection which are the quantitative approach and qualitative approach. “Qualitative research is multi-method in focus, involving an interpretive, naturalistic approach to its subject matter” (Newman and Benz, 1998, p.16). It means attitude from different people to different things. It involves research use and collection from empirical resources such as case study, personal experience and observation, historical, true story and interviews (Newman and Benz, 1998). “Quantitative approach is based on the measurement of quantity or amount. It is applicable to phenomena that can be expressed in terms of quantity” (C.R.Kothari, 2004, p.30). It needs a quantity of data to analysis and then get conclusions.

This research is a qualitative one by using relevant literature that includes books and articles, and a limited number of interviews. Based on these, the expected result aiming at the research is analyzed and explained. The interviews are presented from three aspects: participants, questionnaire and how to be implemented.

- **Participants of interviews**

Five interviews have been finished in order to find out how the migration was implemented in the interviewed companies. Five participants were interviewed. All the participants are from four international telecom companies (A, B, C and D) and located in China, Singapore, Sweden and USA. In order to gain opinions from different management levels, the interviewees had different roles in software development such as vice president, senior project management trainer, software architecture, project manager and software developer. And all have experienced migration from waterfall development approach based on CMM to agile approach.

- **Questionnaire**

The questionnaire used in the interviews is to get the information of implementations in the interviewed companies. It is created from a summary of



literature review and analysis of one case study in an article. After one interview was finished, the questionnaire was analyzed and developed according to the result of the first interview in order to make it more comprehensive. The questionnaire is shown in the Appendix C.

- Interviews implementation

First step for interviews was getting agreement of interview time. And at the same time, consent form which is shown in Appendix B and questionnaire were sent to the participants. Then signed consent forms were collected before starting interviews.

In the five interviews, one was finished by face-to-face meeting, one was from email and the other three were done by telephone. The interviewer focused on asking each question and extended it to try to get more information about the implementation of migration and how to overcome the difficulties in migration.

The entire interviews were finished in two weeks because of global locations. Each of four interviews took around two hours each. Another one took five hours because the participant contributed a lot to share the experience and related theories. And all the interview records are shown in the Appendix C.

### **3.4 Post-production**

After production phase, post-production phase focused on analyzing data and to get ready to resolve research questions (Research Process, 2012).

#### **3.4.1 Analyzing data**

This step aims at data preparation and screening, evaluating materials statistically, analyzing research hypothesis and interpreting the results (Research Process, 2012).

For this research, data analysis is the last step of research and at the same time it is the most beneficial part to gain a conclusion. However, it is the most difficult part because categorizing, organizing, comparing, verifying etc. are needed.

This research data analysis is based on literature review and interviews comparison. Research results are led by data analysis of the differences between waterfall development approach based on CMM and agile approach, the difficulties in the migration, and comparison from theory and implementations in interviewed companies. The interview results from the questionnaire are analyzed in order to contribute to clarify roles and responsibility of a project manager, change management, how to manage process and how project management fits migration. It mainly focuses on how the organization gets over the issues which are caused by difficulties and challenges in migration. Moreover, case study in literature from Donald (2003) is also helpful for data analysis.

### **3.4.2 Publication process**

The last phase focuses on writing down the research achievement, including deciding when to begin writing the paper, running review process, talks, posters or other way to disseminate research (Research Process, 2012). This research follows time schedule in Appendix A. When thesis report draft is finished, reviewed by self and peer group, and coached by the thesis supervisors are started. Then modification is done several times until it satisfied the requirements including completion of this research, correct of language and the format of this report. At last, it is sent to be printed out, bound and stored in secure ways which are defined by Chalmers University of Technology and Northumbria University.

### **3.5 Scope and limitations**

- Scope

The research is focused on how to handle the difficulties in migration. Related knowledge of agile approach, waterfall development approach, process management, communication management and project management are involved. How to setup new process and problems relating to new situations in an

organization are excluded. Problems which are caused by processes but not related to difficulties in migration are also excluded.

- Limitations

This research is limited by time and human resource. Because of using qualitative method, there is a risk at researching some cases' general and simplified characteristics. Migration from one approach to another one is a long term and complicated activity and a lot of challenges and difficulties will turn up in progress of implementation. Some suggestions are obtained from literatures, which needs to be verified in real projects.

### **3.6 Ethical considerations**

Following ethical issues and problems are considered and data protection and secure storage of data are thought over to meet the security standards which are defined by Chalmers University of Technology and Northumbria University. Confidentiality information of companies involved is protected, maintaining the research data from any interested parties or competitive companies. These key issues which possibly turn up are handled with by using the university formal procedures. Moreover, only the author's thesis supervisors and the author have right to all the data.

Human participants have been involved in interviews, and the following items are implemented.

- All the participants are informed about the research.
- All the participants' consents have been obtained using the standard consent form which is shown in Appendix B.
- No deception is involved.
- No participant constitutes a 'vulnerable group' such as under 18 years of age.
- No potential harm to participants.
- The research is not related to commercially, personally or politically sensitive information.
- Not any risk for the report writer and all the participants in this research.

- Data is stored securely in accordance with the guidelines of Chalmers University of Technology and Northumbria University.

## 4 Analysis and discussion

This chapter is divided in four parts. First one is a summary of the findings from literature. The second one presents the data analysis and findings from interviews. Then, comparisons between the findings from part one and part two is given. At the end, suggestions for migration are listed. The structure for this chapter is shown as Figure 4.1.

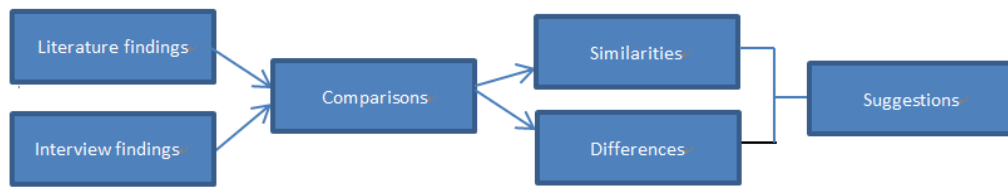


Figure 4.1 Chapter Structure

### 4.1 Findings from literatures

As discussed in literature review chapter, main findings are listed as follows.

- Comparison of the two approaches

The analysis of the comparison between the two approaches provides the possibility to know the difficulties in migration and how to overcome them. Waterfall development approach is a sequential design process. It is plan-driven, well-defined, adequate skills, suitable for large teams, designed for current and foreseeable requirements, and has a series of documentation and processes. Agile approach is incremental change, outcome-driven, change welcomed, collocated, designed for current requirements and has less focus on documentation. The two approaches both have advantages, disadvantages and suitable development environments. There is no better approach or worse approach in software development. Which approach is used depends on the development environment compliance of the two approaches in the organization.

- Before migration

When agile approach is considered to be adopted in one organization, it needs to be analyzed whether the development environment is suitable for agile features or at least whether the organization has potential possibility to put agile approach into practice or not. Environment compliance factors such as typical features, home ground areas and power distance are used to judge migration is suitable for this organization or not and how difficult to implement.

- Difficulties in migration

The main difficulties in migration are changing development model, people factors and communication barriers. People factors mainly lie in how to lead a team to get efficient team work and meeting agile approach features requirements.

Communication aspect is in regarding of communication channels and challenges.

Communication barriers are the difficulties which are caused by team size, technical complexity in the team, different locations and diversity.

- How to overcome difficulties
  - Setting up development environment

Strategies should focus on encouraging feedback from delivery and balancing between structuralism and flexibility in order to make the development process less heavy but not lacking of discipline. Processes and practices are kept as simple as possible and people are encouraged to be self-organized.

- People factors

Strategies are implemented to change management attitude, to adjust project manager and team members' responsibilities and to encourage technical support to each other. For example, making a quality plan, balancing the workload in a team, assessing risks and assigning responsibility are helpful.

- Communication barriers

Strategies aim mainly at setting up communication attitude which is fitful for agile approach, closing physical proximity if possible and adopting the communication tools which have faster feedback speed for globally locations and time zones.

## **4.2 Data analysis and findings from interviews**

The main findings from interviews are discussed and structured in eight areas as follows.

### **4.2.1 General situations**

In company A there was not much difference after the migration compared with the previous ways of working. However, there were fewer processes when using waterfall development approach. After migration, processes became clearer due to having clear iterations and clear priority. In company B, the migration turned out to use a combination of waterfall development approach based on CMM and agile approach. Only certain ways of working such as Stand Up morning meeting, continuous integration and iterations were adopted. But the customer requirements were not divided into smaller parts to achieve. The whole way of thinking was the same as when the waterfall development approach was used. This verified the theory of hybrid approach by Savaged (2010). The waterfall development approach based on CMM has more process adherence, more planning and more measurement data according to CMM standard. That makes the hybrid approach easier to measure after migration. In this company, the agile process was implemented in a more flexible way. In company C, speed, flexibility, adaptability to customer requirements and execution around the clock were optimized by migration. That verified the difference between the two approaches in effect to the customer, team cooperation and power distance. In company D, the software developers thought that agile process was more casual and did not need to be followed seriously. That verified one of the misleading elements of agile approach which was discussed in literature review chapter. In fact, the agile process is more flexible but not casual. The flexible way lies in that the process can be changed by proceeding development of small requirements. The agile approach avoids wasting the effort which does not add value to a product or service. That does not mean the process is casual and works well without following the process seriously.

### **4.2.2 Delivery timing**

In all the interviewed companies the project delivered more timely after migration. In company B delivering on time was one of the measurements for project performance. In order to get better project performance, the customers'

requirements were divided into iterations according to delivery deadline instead of the features in the software. For example there were three iterations in one project, if the second one needed a longer time according to the features in the software, then in order to deliver the second iteration timely, some features which needed to be fixed in second iteration were moved into the third one. As a result, the project could deliver on time or even earlier than the deadline when it needed. In company C less time was spent on elaborating the ideal planning when using waterfall development approach. But more time was used to track changes and to define corrective actions after migration.

#### **4.2.3 Documentation**

In company A there was still a series of documentation after migration except in coding phase. The negative aspect was that time used for testing and verifying were more than when the waterfall development approach was used. And in order to decrease the number of documentation, some project teams cut down the number of iterations. That is not the original aim for migrating to agile approach. There was almost no change for the requirement of general design and features documentation in company B. However, there were more changes of documentation after migration existed in detailed design document. In waterfall development approach, it is more difficult to track change compared with in agile approach. Before migration, sometimes it turns out that the documented implementations are different to those that were defined at the beginning. Because after changes happened in waterfall development approach, it is sometimes needed to modify and track all the related modifications synchronously. As for the agile approach, the documentation is finished during the process of implementations. So the documentation is closer to the defined implementation. In company D, there was less documentation after migration. But the project team could still make sure the project quality. Because the quality lies in whether the result matches with what it was defined. For the agile approach, the whole requirement is divided into the smaller ones for all iterations. The requirements are closer to customer requirements because they have been verified at the end of each iteration. Furthermore in this company, after migration there was a final report for each software version. It included all the parts in the documentation when the waterfall



development approach was used. The final report can be beneficial for the future projects.

In most implementations in the interviews, the documentation is decreased after migration. On the other hand, the quantity of documentation can get larger if there is still a series of documentation required in most of the phases as the waterfall development approach was used. Documentation is finished in the process of implementation in the agile approach. As a result, the documentation is done closer to implementations.

#### **4.2.4 Project manager's responsibility**

It is recognized in all the interviewed companies that there is a fundamental difference in the project manager's responsibility after migration. Before migration the project manager was more like a coordinator and in charge of all the activities of the project. After migration the project manager's role of planner and controller changed to that of a facilitator which focused on directing and coordinating the collaborative efforts. That may have contribution to ensure that the creative ideas of all participants in software development can be reflected into decision making. For the process development, making some strategies to let everyone be involved in decision making and motivating and clarifying the responsibilities of team members are suggested.

#### **4.2.5 Communication and feedback**

In company B, the communication frequency increased and the feedback from delivery and communication were more effective after migration. That verified that in agile approach there needs to be more effective and timely communication. No major difference in communication tools was observed. More phone meetings were used in the global teams. Emails were used and main agendas in formal meetings were recorded in the form of meeting minutes. In company C there were more requirements for all the team members after migration. Physical working place and clearer requirement were agreed on to be helpful when using agile approach. The benefits from working together is to make it more convenient to communicate and easier to track the progress for the team members and processes.

Problems, experience and lessons in the progress of projects are discussed and shared timely. However the negative side of it is less private room and more disturbances between team members. For example when one team member is in a call, all the other team members can hear and can be one of the distraction factors for some people. In company D a task board which included story, what to do, what in progress, what to verify and what has been done, face to face communication and meetings was commonly used after migration.

It turns out that the feedback from customers and previous iteration was found to be helpful for continuous learning, adaptation and optimization. Customers and agile teams work jointly throughout the project was also found to be beneficial for migration.

#### **4.2.6 Difficulties in migrating**

In company A, the most difficult part of the migration was communication barriers. In company B the main difficulties existed in the awareness of agile characteristics, team members' capability, trust among team members and an active working style. And it was lack of rhythm to software development, less plans in project team than when waterfall development approach was used in this company. In company C the main challenges were the people factors related to changing their mind-set and getting them to move to the new way of working. The development environment looked chaotic for well-organized and well-structured team members after migration. In company D the agile environment in the team was the most difficult area. It was related to new mind-set and the way of thinking for project managers and team members.

The interviews verified the theory of the three most difficult factors in migration. How to set up agile development environment and how to change team members' mind-set to accept the agile approach should be considered for migration. Moreover, management hierarchy is still the main factor of decision making after migration in the interviewed companies.

#### **4.2.7 Compliance**

Compliance is about whether the organization is fit for migration or not from waterfall development approach to agile approach. In company A, the project team performed better when having clearly defined roles and responsibilities after migration. The more rush for requirement made; the harder to share resources with other teams. In company A and D it was easier to get good project performance when every team member was more mature and more experienced. In company B, the compliance of development environment was the most important factor of the migration. Recognizing the importance of the agile culture from senior leaders was significant for migration success. In company C, there were more flexibility and closeness to the customer after migration. Moreover if the team members were adaptive, the migration was easier to implement.

Take change request (CR) as an example in companies A, C and D, team members were accustomed to CR in the waterfall development approach, it was easy for them to accept to putting the new change in another iteration after the agile approach was adopted. And that all the requirements needed to be recorded in documentation and be tracked after the iteration where it was integrated. In the waterfall development approach, CR belongs to change management. Those responsible who are in the charge of changes need submit one CR for this change in software development system. The CR experiences submission, approval which means this change is accepted, implementation which shows this change is in the process of integration, track which is for making sure all the change is finished. When the process of this CR is finished, all the modifications including software requirements specification and detailed design document is finished modified and last step is backtracking, which is for the purpose of having a double check whether there is new change needed or some issues because of the first change. As for the agile development approach, if there is a new change proposed and accepted, the new change is considered as one new requirement and is put in the iteration where is suitable.

#### **4.2.8 Migration result**

The results after migration were quite different in the different interviewed companies. When the development approach is changed, it needs some time for the team members to make the new way of working as effective as the former approach. Not every organization is fit for agile approach. Some projects fail or make more effort in the development process. In some companies, the agile approach was adopted only in specific ways of working such as scrum meeting in the morning; documentation was assigned to every iteration; or agile approach was adopted only in development phase but other steps work in the same way as when the waterfall development approach was used.

#### **4.3 Comparisons of findings from literature review and interviews**

There are both similarities and differences in findings from literature review and interviews.

In a summary, most findings from the two aspects are similar such as:

- In agile approach it is easier to deliver timely, which is one of the agile approach features mentioned in literature review chapter.
- More focus is put on customer demands in most interviewed companies after migration. It is fast, flexible and adaptive to customer requirements.
- The project manager and the members' responsibilities are changed in migration. That is verified in all the interviewed companies. It is called a fundamental difference. In the waterfall development approach, the project manager is more of a coordinator managing all the activities of the project. The project manager is doing very little in case the project is in trouble. In the agile approach, the project manager is focused on the end results. The project manager steps back from power and sends out more responsibilities to team members. As a consequence, team members have more responsibilities and are welcomed to share experience and lessons compared with when using waterfall development approach.

- Communication in agile approach is supposed to be more flexible in communication tools. But for formal files and contracts, strict records are still needed to inform the project management.
- The main difficulties in migration are development environment, people factors and communication barriers. After resolving these three barriers, migration is much easier to let team members get used to this new approach and make implementation successful.

On the other hand, when migration is completed, the situations are different in various organizations. And migration does not entirely go in the way according to the related literatures. There are some differences between the findings from literature review and interviews.

- Documentation is designed to be decreased in agile approach because the documentation only done when it is actually needed according to the literature review. In some companies, documentation is really less than in waterfall development approach. But in some companies, a series of documentation is still needed in all the iterations. As a result, the quantity of documentation is larger than in the waterfall development approach.
- The development processes in agile approach are more flexible, for example, the iteration period and main tasks in each iteration can be decided and changed by the project team during software development. It depends on customers' requirement and delivery deadline. But it does not mean the iteration period can be determined casually. In one interviewed company, agile approach was considered to be implemented casually and there was no need to follow the development processes seriously.
- According to Cockburn and Highsmith (2001), maturity of team members does not mean that agile approach require uniformly high-capability people. A lot of agile projects achieved successfully with mixes of experience and junior team members, which is the same as in waterfall development approach projects. However, team members' maturities were considered to be an important factor for migration in all the interviewed companies.

## 4.4 Suggestions for a successful migration

According to literature review and implementations in interviewed companies, suggestions for migration from waterfall development approach based on CMM to the agile approach are listed. They are divided into four parts, which are listed as in Table 4: preparation, environment, people and communication.

Preparation	Environment	People	Communication
Fit or not  Not in all phases  In a small scope	Set development environment  Give vision  Share knowledge  Support  Track and audit	Experienced team  Adjust responsibility  Clarify roles	Work close  Attitude  Handoff  Tools  Power distance

Table 4.1 Suggestions Structure

### 4.4.1 Suggestions in preparation phase

- Fit or not

Consider whether the organization is fit or not to adopt the agile approach at the beginning. Not all the organizations and projects can get better achievements after migrating from waterfall development approach to agile approach. In the practical implementations, some migrations fail; some migrations have not added any value to the projects. Home ground areas and features of the development environment which were mentioned in literature review chapter can be referenced to judge whether agile approach is suitable for the organization or not. Moreover, the culture such as whether requirement change is welcomed all through the SDLC, and power distance in different countries can be factors to be considered as well. There should be a steady shift from the waterfall process model to agile process model; otherwise there is a risk of failure.

- Not in all phases

Agile approach goes well in the period between the planning phase to the development phase. It is contributed to divide software development requirements into smaller requirements and deliver by iterations in order to make change management easier. It is no need to adopt in every phase. For some phases like the maintenance phase, it is for keeping software stable and doing customer service. In this phase, one entire part after software development is finished and delivered. If it is divided, it is more difficult to separate roles and responsibilities for servicing customers.

- In a small scope

The next suggestion is implementing agile approach in a small scope. Moreover it is better to try the migration in one project, in which there are lots of requirements of changes. Hence, it is more obvious to provide the difference after migration and it is easier to track the project process in such projects. For this reason, this implementation helps to find risks and difficulties in specific organizations. It can be beneficial to decide whether further scope of migration can be adopted or not. In order to measure whether agile approach is beneficial or not for the organization, an implementation approach where the agile way of working is introduced in a small scope and selecting a project which has frequent changes is recommended.

#### **4.4.2 Suggestions in development environment**

- Set development environment

The agile approach requires highly efficient leadership and more collaboration, as compared to the command and control management style existing in the waterfall development management approach (Nerur et al. 2005). The participatory culture process needs team members to be involved and to make decision effectively. In the progress of making decisions, the business goals and directions should be known by agile teams.

Setting up an agile development environment is about making it easier for team members to get used to the new development approach. Development environment

includes: rapid feedback to communication, awareness of agile process is more flexible but not casual, working incrementally with iterations, changing the resistance to iterative, trust, respect, self-organized, self-disciplined, contributing from every team member, and change making to be welcomed. Moreover, taking top management in confidence by the project teams to achieve success is also suggested.

- Give vision

When the migration is started, giving the team vision is significant for letting the team understand why the agile approach is being adopted and what value can be brought. At the beginning of migration, the first reflection of the team is trying to avoid changes. Following aspects are advised to be mentioned and addressed such as: how to motivate team members to accept a new approach, to understand why the organization migrates from the waterfall development approach to agile approach, and what the project performance can be changed and optimized because of the migration.

- Share knowledge

In addition, setting up motivation of trust and knowledge sharing among the team members are suggested to make technical experts available to the team, or even better, to be the part of the project team. It is in order to give training for team members and make team members to be aware of agile approach characteristics. Such as team members' capability, trust among team and activate working style. It is also helpful to get an experienced coach to work with the team for a while after migration. At the same time, giving an overview presentation and training is also vital to not only for development team members but also for senior managers to change mind-set from waterfall development approach to agile approach.

- Support

In agile development approach, team members are required to be more mature in technique and communication skills. In order to make migration smooth and work in high efficiency, the support coming from technique and processes are suggested. It is helpful for the team to know what they are doing, why software is developed in such a way, how to implement a new process and the new working style, and



can get help from professional support in technique when there is an issue happening, especially at the beginning of the progress of migration.

- Track and audit

Tracking and auditing project performance in the process of migration implementation are suggested as well. It is easier within the agile approach to implement compared with in the waterfall development approach. For example, software development requirements are divided into small ones and as a result when agile approach is adopted, delivery is achieved from iteration to iteration. When the previous iteration is finished, the delivery can be tracked and audited whether the agile process is implemented in the way which is supposed to or not. After doing auditing for delivery, experiences and lessons can be used to optimize the next iterations.

#### **4.4.3 Suggestions in people factors**

- Organize experienced team

To employ experienced team members is advised, which means selecting the right project and the right people in a limited range. Compared with the waterfall development approach, team members in agile approach are more independent from other team members or project resources. Employing experienced team members can make the team work easier to be understood and finish the tasks more efficiently.

- Adjust responsibilities and clarify roles

In the agile approach, the project manager is supposed to step back from power and hierarchy in waterfall development approach. Clear responsibilities are made for the project and it makes sure that the project manager steps back from being a protector and coach with less hierarchy. Everyone's contribution is welcomed. It is also suggested to have more strategies to motivate team members' participation.

Clarifying definition of roles and each responsibility at the beginning is beneficial in order to make everyone know exactly what is supposed to be in charge of and what is the relationship between the members from this team and other teams.

#### **4.4.4 Suggestions in communication**

- Attitude

Encouraging every team member to be active, honest, open minded and to respect in communication is recommended. Setting up a free communication environment is important in which the team members can speak out their opinions, compliments and suggestions of what they think about and how to optimize the team work.

- Work close

For the agile development approach, the ideal working environment is the physical closeness in working conditions, tools and resources in order to work effectively in communicating and collaborating. As a result, the team can share knowledge and improve their ideas on how to solve the problems at hand. For large organizations especially for global ones across locations, countries and time zones, specific communication tools such as high-speed internet connections, video and some other virtual tools are adopted (Linders, 2010).

In order to reduce the cost of exchanging information, team members may get physically closer to work, for example by sitting together. It is difficult for a global organization with distributed offices and different time zone. As discussed, working together geographically has two sides: a positive one and a negative one. In order to get the benefit from the positive side and decrease the risk from negative factors as much as possible, working together but not sitting on the same table in local organization or each site for global team is suggested. As a result, it is easier for team members to communicate more conveniently but still have separated spaces to avoid being disturbed by the other team members. Dividing and assigning tasks according to the location is suggested for the headquarters in distributed organizations. Such as drawing up 15 to 25 percent less achievement aim to other sites compared with headquarters is suggested.

- Handoff email

Handoff email is useful for overcoming communication barriers in a large team in which one team member summarizes work every day for all the team and sends out to team members who are in other locations. It is beneficial for the remote team to know what have been finished, what is the plan for next step and what are the difficulties in high efficiency.

- Tools

According to the theory of the relation between communication channels and effectiveness from Ambler (2002), which was mentioned in literature review chapter, an organization can adopt communication tools such as face-to-face whiteboard, face-to-face conversation and video conversation for large teams. For global teams, more phone meetings are suggested. For the formal conclusions, emails can be used for recording meeting minutes.

- Power distance

How culture influences individualism and power distance in different countries is suggested to be considered during the progress of migration. It shows the result in some countries according to Hofstede (1984), which was discussed in literature review chapter. The discussion is divided into four areas which are low Power Distant (PD) with Low Individual, Low PD with High Individual, High PD with High Individual, and High PD with Low Individual. The larger of PD, the lower Individual, more difficult the migration is. For the migration in the countries with higher PD or lower Individual, it is suggested that more attention is paid on strategies to adjust responsibilities and motivating team member.

## 5 Conclusion

This chapter is a summary of the whole thesis including main conclusions and further research.

The research question has been discussed and answered in the Analysis and Discussion chapter. Moreover, the suggestions on how to migrate successfully from a waterfall development approach to an agile approach have been given in four aspects: preparation, development environment, people factors and communication.

### 5.1 Main conclusions

The waterfall development approach based on CMM and agile development approach have each advantages, disadvantages and suitable development environments in software development. The migration process is an attempt to bridge the gap between the two approaches.

In the progress of migration in an organization, the balance structuralism and flexibility should be considered, in order to make development process is less heavy but still not lacking discipline. Free style does not mean to neglect principles. It means documentation and processes are designed and used only when they are needed.

The two approaches have each characteristic and there are similarity and differences between them, such as software development life cycle period, standard of documentation, the way of thinking in project management, communication pattern, feedback and reflection to customer requirements, project members' responsibilities and change management type.

The biggest difficulties lie in how to change and adopt the agile approach within development environment, people factors and communication methods. Regarding to the development environment, it is significant to change attitudes towards the new approach to set up the agile approach development environment and to change team members' mind set toward agile approach. As for the people factors, it is related to change project members' responsibilities, which belongs to management style. Pertaining to the communication barriers, the communication with more frequent and faster feedback is needed. That is why adjustment of communication tools should be considered.

There are several factors that impact the performance migration in an organization: culture in different countries, the maturity of technique, cooperation between team members and the original development environment. The implementation of migration achieves different effects from interviewed companies and the case study from literature review.

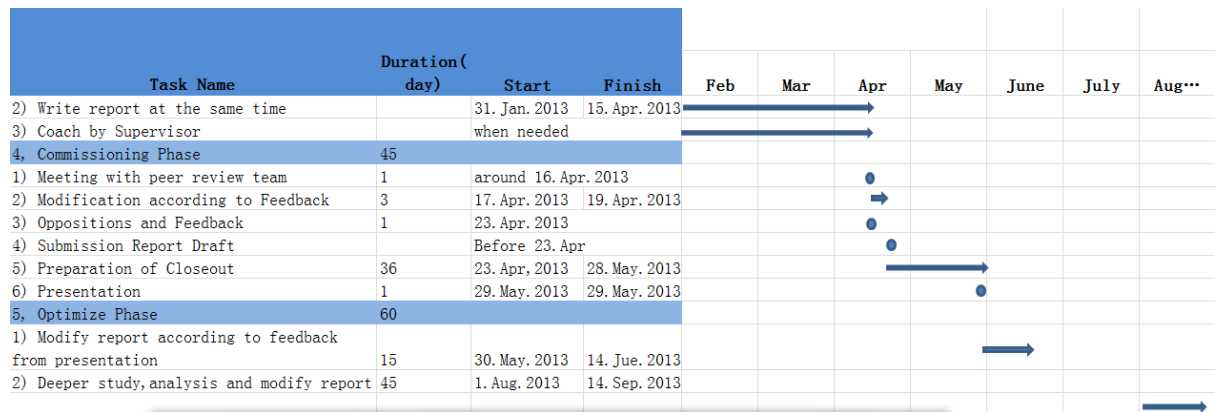
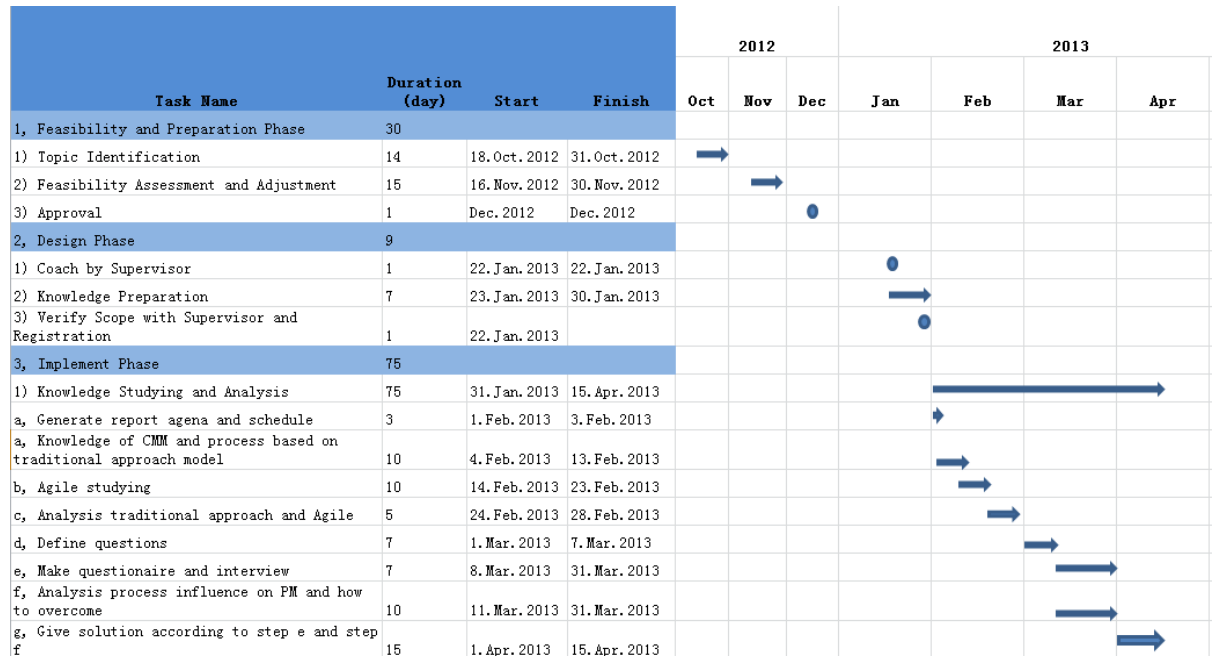
## **5.2 Further research**

This research is limited by time and human resource. It focuses on migration from the waterfall development approach based on CMM to agile approach.

In the further research, migrating from process angle and how to make migration smoother from a process optimization aspect should be given more focus.

Undertaking research from more aspects such as culture and psychology are also of interest. How to do process development step by step; what are the factors from different angles such as cultural, process, hardware development aspects are not involved in this research. But these perspectives are important and necessary for systemic process development and can be analyzed in further research.

# Appendix A - Thesis Gant Chart



# Appendix B - Consent Form



Name of applicant:	_____
Organization:	_____ (If applicable)
Project title:	_____
Name of student:	_____
Programme of study:	_____
Name of supervisor:	_____

## Standard statement of participant's consent

I confirm that:	
1. I have been briefed about this research project and its purpose and agree to participate	YES / NO
2. I have discussed any requirement for anonymity or confidentiality with the researcher	YES / NO
3. I agree to being audio taped/ videotaped during the interview	YES / NO
* Participants under the age of 18 normally require parental consent to be involved in research.	
** See the section below for any specific requirements for anonymity or confidentiality.	
Signed: _____	Date: _____

Specific requirements for anonymity or confidentiality
--

<b>Standard statement by researcher</b>	
I have provided information about the research to the research participant and believe that he/she understands what is involved.	
Signature of researcher: _____	Date: _____

# Appendix C - Interview Questionnaire and Records

Questionnaire for interviews:

- Basic information
  1. What is your role and responsibility in development team?
  2. What experience do you have from of working with SW development with a plan-driven (traditional) approach
  3. What experience do you have from of working with SW development with an agile approach?
  4. What is the general difference in your experience?
  5. Have you experience migrate from plan-driven approach to agile?
- The time – quality conflict
  6. As for process adherence, is there a difference/conflict between traditional SW development and in agile development?
  7. As for delivery on time, is there a difference/conflict between traditional SW development and in agile development?
- Usage of documents & responsibility & clear requirement & physical working place
  8. Have the requirements on documentation, for example testing reports, been modified a lot from waterfall development approach to agile approach? (discuss e.g. whether it is good to cut down some documents for testing even if this is in conflict with the needs of QA or other teams? What kinds of documents are necessary?)
  9. Is there a difference in the project manager's responsibility in waterfall development approach as compared to the agile approach, for instance in choosing team members, and quality assurance assistance?
  10. What is the role of QA in agile approach? Has the QA authority to stop development teams, not adhering to processes?
  11. In some organizations, team members move together to work (e.g. in Huawei). What are the benefits of doing so? What are the negative effects?



12. How important are clear requirements in traditional SW development? In agile development?
13. How important are effective feedback and communication tools in traditional SW development? In agile development? Is there a difference between the tools used?
- Migration from traditional SW development to agile
  14. What is the main difficulty in migrating from traditional SW development to agile approach?
  15. What is the main change in your team since you adopted agile?
  16. What is your suggestion of process optimization for agile?
  17. In your opinion, which requirements do agile as a work form put on
    - a. The organization?
    - b. The development process?
    - c. The team members?

## Interview Records:

Interview 1: from vice president in an international company in IT industry in Singapore.

### ● Basic information

#### 1. What is your role and responsibility in development team?

I am the general manager of the organization including the development teams. My role is to set SMART (Specific, Measurable, Achievable, Realistic and timely) objectives with the R&D managers, and then to manage the review process. This review process is done on a weekly and monthly basis with different objectives.

#### 2. What experience do you have from of working with SW development with a plan-driven (traditional) approach

project management has evolved over time, speed and quality has become a major challenge

#### 3. What experience do you have from of working with SW development with an agile approach?

The most recent customer projects have made used of the agile approach.

#### 4. What is the general difference in your experience?

Speed, flexibility, adaptability to customer requirements, and execution around the clock

#### 5. Have you experience migrate from plan-driven approach to agile?

the changes have been smoothly made without explicitly referring to the agile method

### ● The time – quality conflict

#### 6. As for process adherence, is there a difference/conflict between traditional SW development and in agile development?

agile method put much more focus on customer demand. Thus the activities are much more time driven and everything is done to meet the time schedule whatever are the consequences on the working hours, on number of people allocated to the project.

#### 7. As for delivery on time, is there a difference/conflict between traditional SW development and in agile development?

There are differences, it is a different mind-set. You spend less time to elaborate the ideal planning, you spend more time to track versus objectives and to define corrective actions when you deviate from the objectives

- Usage of documents & responsibility & clear requirement & physical working place

8. Have the requirements on documentation, for example testing reports, been modified a lot from waterfall development approach to agile approach? (discuss e.g. whether it is good to cut down some documents for testing even if this is in conflict with the needs of QA or other teams? What kinds of documents are necessary?)

The documentation focuses on the end results, so the results of the test of the use cases, instead of having documents that describe how you execute the development. Again, the focus is very much on the end results. The results of the test of the use cases defined the quality level. So the more you progress, the higher is the quality of the deliveries of the projects.

9. Is there a difference in the project manager's responsibility in waterfall development approach as compared to the agile approach, for instance in choosing team members, and quality assurance assistance?  
yes, there is a fundamental difference. In the traditional approach, the project manager is more a coordinator reporting the status of the project whatever it is. The project manager is doing very little in case the project is having trouble. In the Agile approach, the project manager is also focused on the end results. Thus the project manager is fully empowered to take the needed corrective actions and to escalate any requests for support in case of needs.

10. What is the role of QA in agile approach? Has the QA authority to stop development teams, not adhering to processes?

In the Agile approach, the QA has the duty to set incremental Quality objectives which are perfectly matching the customer demand, so the QA needs to be very close to customer QA

11. In some organizations, team members move together to work (e.g. in Huawei). What are the benefits of doing so? What are the negative effects?

I don't understand

12. How important are clear requirements in traditional SW development? In agile development?

In any activities, requirements are essential to ensure that the team will execute the right project. In the Agile way of working, those requirements are dynamically reviewed very regularly with the customer. Trade-offs are also reviewed in order to keep adherence to the project schedule and the QA objectives

13. How important are effective feedback and communication tools in traditional SW development? In agile development? Is there a difference between the tools used?

As Agile way of working is much more dynamic, the tools need to enable this dynamics. It is about communication tool for daily review, it is about errors tracking, it is about task management ...

- Migration from traditional SW development to agile

14. What is the main difficulty in migrating from traditional SW development to agile approach?

the main challenge is people, to change their mind set, to get them moving to the new way of working which may look more chaotic for very well-organized and well-structured people and team

15. What is the main change in your team since you adopted agile?

Passion and motivation have increased. Engagement and commitment to timely execution has improved.

16. What is your suggestion of process optimization for agile?

Any process needs to have its own KPI's in order to make sure that the organization will continuously improved

17. In your opinion, which requirements do agile as a work form put on

- a. The organization?

more flexibility, closer to customer

- b. The development process?

better tools, better review, often tracking

- c. The team members?

Adaptability, higher commitment, no limit to working hours, please the customer

Interview 2: from a developer in an international company in IT industry in China.

- Basic information

1. What is your role and responsibility in development team?

Role: Software developer

Responsibility: software development

2. What experience do you have from of working with SW development with a plan-driven (traditional) approach?

3 years.

3. What experience do you have from of working with SW development with an agile approach?

From the year of 2005, do software development using traditional approach.

From 2008, agile was adopted

4. What is the general difference in your experience?

Agile is more iterate, shorter lifecycle and faster achievement.

5. Have you experience migrate from plan-driven approach to agile?

Yes. But at the present, the migration turns out to use a combination of waterfall development approach and agile approach. Only methods are being used instead of essence of agile approach. Scrum morning meeting, continual integration and iteration are kept and benefiting. Personal think, firstly whether the organization is fitful for agile approach should be considered.

Agile is fitful for huge organizations.

- The time – quality conflict

6. As for process adherence, is there a difference/conflict between traditional SW development and in agile development?

Agile process is more flexible, casual. Process model is set up by project manager according to every specific project. The advantage is that process can be customized by QA and project manager. There are more measurement data in CMM standard which is easier to measure and more strictly.

7. As for delivery on time, is there a difference/conflict between traditional SW development and in agile development?

Agile approach does better job on delivery on time. For example, there are three iterations in one project. The project can be delivered when the second iterations are finished and put the last iteration into the next step. In waterfall development approach, the project can deliver when all steps of this project have been finished.

- Usage of documents & responsibility & clear requirement & physical working place

8. Have the requirements on documentation, for example testing reports, been modified a lot from waterfall development approach to agile approach? (discuss e.g. whether it is good to cut down some documents for testing even if this is in conflict with the needs of QA or other teams? What kinds of documents are necessary?)

As for waterfall development approach, it is difficult to track change. Moreover, sometimes it turns out that the implement is different with documents which are finished at the beginning. As for agile approach, the documents are finished in the progress of implementation. As a result, the documents are closer to implement which are concluded by proceeding.

Delivery is used for measurement. As a result, in order to decrease documents, some project teams cut down quantity of iteration. It is not the original aim for agile approach. Agile approach is alike many waterfall development approach steps. As for documents, there is still series of documents like waterfall development approach except coding phase. There is one negative aspect that is time cost in testing and verifying is too much. For example, for projects coding only takes less than 20% time.

9. Is there a difference in the project manager's responsibility in waterfall development approach as compared to the agile approach, for instance in choosing team members, and quality assurance assistance?

Almost nothing difference.

10. What is the role of QA in agile approach? Has the QA authority to stop development teams, not adhering to processes?

QA team plays a suggestion role which is not important in agile approach. They are responsible to track process, making models of documents and checklists without coaching project.

11. In some organizations, team members move together to work (e.g. in Huawei).

What are the benefits of doing so? What are the negative effects?

The benefits are more convenient communication and easier track of people and process. The negative is less private room and more disturb, for example when one team member is in a call, all the other team members can hear and can be one of the distraction factors for some people.

12. How important are clear requirements in traditional SW development? In agile development?

Agile approach does better job for requirement management. As for traditional SW development, requirements are made at the beginning of project. On the other hand as for agile approach, the requirements are set up and changed as proceeding iterations which make them clearer for development team and customer.

13. How important are effective feedback and communication tools in traditional SW development? In agile development? Is there a difference between the tools used?

Little difference exists between the two approaches. For agile approach, communication becomes more often and at the same time earlier for test involved.

- Migration from traditional SW development to agile

14. What is the main difficulty in migrating from traditional SW development to agile approach?

Main difficulty mainly exists in awareness of agile characteristics, team members' capability, trust among team and activate working style.

15. What is the main change in your team since you adopted agile?

Main changes are shorter project lifecycle, clearer customer requirement, higher code quality and more closer to actual situation. Furthermore, project

performance measurement changes. For example, in order to get better performance, some iterations are delayed to next milestone.

16. What is your suggestion of process optimization for agile?

Personal think, firstly implement migration in small range. Secondly, try the migration in a project which has lots of requirement change. Lastly, employ experienced people. All in all, select right project and right people in limited range.

17. In your opinion, which requirements do agile as a work form put on

a. The organization?

It is the most important factor. Recognizing the important of agile culture from senior leader is significant for success.

b. The development process?

c. The team members?



Interview 3: from a senior project manager in an international insult company in Sweden.

Want to be mentioned.

- Basic information

1. What is your role and responsibility in development team?

Role: Senior Project Manager

Responsibility: Give project management training in many countries.

2. What experience do you have from of working with SW development with a plan-driven (traditional) approach?

4 years. Give project management training related to SW development.

3. What experience do you have from of working with SW development with an agile approach?

Have used scrum method. Give project management training related to SW development.

4. What is the general difference in your experience?

Effect: More customer satisfaction in agile approach. The agile team does the thing exactly for customer that they want with less mistake of customer requirement.

Team: Agile team gives out responsibility. As a result, the team members involve more decision making which make them be more active, happier to work and work harder. And more trust in agile team. At the same time, the team members become be expert for more areas, compared with waterfall development approach team where it is enough to be expert in some specific areas.

Power distance: Agile team has less power distance compared with waterfall development approach team, according to Geert Hofstede theory of culture dimensions.

5. Have you experience migrate from plan-driven approach to agile?

Yes.

- The time – quality conflict
6. As for process adherence, is there a difference/conflict between traditional SW development and in agile development?

Process in agile approach is more flexible but agile team follows more than waterfall approach team.

There is one misleading of agile that agile process is more casual and does not need to follow seriously. In fact, agile process is more flexible but not casual. The flexible way of agile process lies in that process can be changed by proceeding development of smaller requirement. And agile approach avoids waster which does not add value to a product or service. The reason is that whole requirement is divided into phase requirement to be fit for all iterations and the final report can include all content the same as waterfall approach does.

7. As for delivery on time, is there a difference/conflict between traditional SW development and in agile development?
- Agile approach does better job. As for waterfall approach, milestone period is longer and mostly guess is used to evaluate how many have been finished.

- Usage of documents & responsibility & clear requirement & physical working place

8. Have the requirements on documentation, for example testing reports, been modified a lot from waterfall development approach to agile approach?  
(discuss e.g. whether it is good to cut down some documents for testing even if this is in conflict with the needs of QA or other teams? What kinds of documents are necessary?)

There are more documents in waterfall development approach. But agile approach can still make sure quality because requirement quality lies in whether the result matches what it is supposed to be. For agile approach, the whole requirement is divided into smaller ones for all iterations. However, the requirement is closer to customer requirement because more requirement verification has been done at the end of iterations. And there is final report which includes all the parts in waterfall approach to future project in agile

approach. Agile approach has better communication than document. At the same time, record should be kept to be proof and documentation.

9. Is there a difference in the project manager's responsibility in waterfall development approach as compared to the agile approach, for instance in choosing team members, and quality assurance assistance?

In agile approach team, project manager hands out more responsibility to team members, compared with waterfall approach team. As a result, the agile project manager should be careful to do that and step back a little more during the development.

10. What is the role of QA in Agile approach? Has the QA authority to stop development teams, not adhering to processes?

QA team can use related tools such as TDD (Test Driven Development), pair programming which is two team members do programming together to discuss, peer review and so on.

11. In some organizations, team members move together to work (e.g. in Huawei). What are the benefits of doing so? What are the negative effects?

Benefits are faster communications, overhearing from thinking from other teams. At the same time, overhearing can bring disturbing. All in all, in general sitting together to work is positive.

12. How important are clear requirements in traditional SW development? In agile development?

Agile uses more verification, communicating directly to get less misunderstanding.

13. How important are effective feedback and communication tools in traditional SW development? In agile development? Is there a difference between the tools used?

In agile team, task board which includes story, what to do, what in progress, what to verify and what has been done, face to face communication and meeting are common used.

- Migration from traditional SW development to agile

14. What is the main difficulty in migrating from traditional SW development to

agile approach?

Agile culture in this team is most difficult that is new mind set and way of thinking for project managers and team members.

15. What is the main change in your team since you adopted agile?

Team members get more responsibility and know more knowledge across different areas.

16. What is your suggestion of process optimization for agile?

Firstly, not all the departments need agile methods. Agile is good to be used the period which is between planning phase to development phase. As for requirement, agile phase is before whole requirement is set up.

Secondly, experienced coach that is working with the team after adoption for a while is important. At the same time, training is not only for development members but also for senior managers to change mind set.

Last but not least, rolling out change plan that is mind set, measure performance using KPI and checklist, and motivating team members are helpful.

17. In your opinion, which requirements do agile as a work form put on

- a. The organization?

It is difficult for global organizations but still possible.

- b. The development process?

- c. The team members? Board-skilled and team work are needed.

Interview 4: from a project manager in an international company in IT industry in China.

- Basic information

1. What is your role and responsibility in development team?

Role: project manager

Responsibility: architecture, design development

2. What experience do you have from of working with SW development with a plan-driven (traditional) approach?

5 years. Has coded, been module leader.

3. What experience do you have from of working with SW development with an agile approach?

2 years. Has designed migration.

4. What is the general difference in your experience?

Waterfall development approach: Longer development lifecycle and better to freshman because they are under less pressure and higher efficiency.

5. Have you experience migrate from plan-driven approach to agile?

Yes.

- The time – quality conflict

6. As for process adherence, is there a difference/conflict between traditional SW development and in agile development?

Waterfall development approach has more process adherence and more plan.

7. As for delivery on time, is there a difference/conflict between traditional SW development and in agile development?

Agile does better job in this aspect because issues can be found easier and earlier.

- Usage of documents & responsibility & clear requirement & physical working place

8. Have the requirements on documentation, for example testing reports, been modified a lot from waterfall development approach to agile approach?

(discuss e.g. whether it is good to cut down some documents for testing even

if this is in conflict with the needs of QA or other teams? What kinds of documents are necessary?

There is almost no change for general design/feature/solution documents. More change exists in detail design documents. Agile approach plays more coach role because when some document is finished and then will get involved into next step. For example, as for test reports, all features test reports are needed in one whole test report. For agile approach, all features are tested in different iterations. So personal think, agile approach is more implemental but the content is almost the same.

9. Is there a difference in the project manager's responsibility in waterfall development approach as compared to the agile approach, for instance in choosing team members, and quality assurance assistance?

It is stricter with PM in CMM for plan. Agile has more requirement for every team member and those whose responsibility of finding the issue.

10. What is the role of QA in agile approach? Has the QA authority to stop development teams, not adhering to processes?

Personal think QA has no authority to decide plan but can stop software development if quality is not good enough.

11. In some organizations, team members move together to work (e.g. in Huawei). What are the benefits of doing so? What are the negative effects?

The benefit is easier to communicate without block between team members. The negative aspects are less room to think over, for example, there are only few team members who are familiar with this area.

12. How important are clear requirements in traditional SW development? In agile development?

Personal think, there is no clear difference in clear clarify. For customer aspect, clear clarify has been finished at the beginning that is general design or feature design. For change management, agile does better job.

13. How important are effective feedback and communication tools in traditional SW development? In agile development? Is there a difference between the tools used?

Agile approach does better job for effective feedback. Agile needs more effective and on time. As for communicate tools, there is no much different.

For global, when agile approach is adopted, more phone meeting is needed.

For formal meeting, mail is used often and at least there is meeting minutes needed.

- Migration from traditional SW development to agile

14. What is the main difficulty in migrating from traditional SW development to agile approach?

Lack of rhythm to software development that is fewer plans in waterfall development approach.

15. What is the main change in your team since you adopted agile approach?

In agile approach, deadline is closer and clearer. As a result, team members feel more pressure to finish tasks before deadline.

16. What is your suggestion of process optimization for agile?

No.

17. In your opinion, which requirements do agile as a work form put on

- a. The organization? More rush for requirement, so it is harder to share resources with other teams.
- b. The development process? No.
- c. The team members? More requirements for team members such as higher level technique, less time to study and adapt.

Interview 5: from a developer in an international company in IT industry in America.

- Basic information

1. What is your role and responsibility in development team?

Role: Developer

Responsibility: all through software development.

2. What experience do you have from of working with SW development with a plan-driven (traditional) approach

6 years.

3. What experience do you have from of working with SW development with an agile approach?

2 years.

4. What is the general difference in your experience?

Each has advantage in different context. Agile is more iteration but waterfall can as well. No much difference.

5. Have you experience migrate from plan-driven approach to agile?

Yes.

- The time – quality conflict

6. As for process adherence, is there a difference/conflict between traditional SW development and in agile development?

Waterfall has less. Agile has very clear iterations and has clear priority, then review. As a result, agile has clear process.

Waterfall does not mean CMM and agile does not mean casual.

7. As for delivery on time, is there a difference/conflict between traditional SW development and in agile development?

Agile does better job in delivery on time. Agile has defined that can be finished.

- Usage of documents & responsibility & clear requirement & physical working place



8. Have the requirements on documentation, for example testing reports, been modified a lot from waterfall development approach to agile approach?  
(discuss e.g. whether it is good to cut down some documents for testing even if this is in conflict with the needs of QA or other teams? What kinds of documents are necessary?)  
No different. When using agile, the documents are same.
9. Is there a difference in the project manager's responsibility in waterfall development approach as compared to the agile approach, for instance in choosing team members, and quality assurance assistance?  
Waterfall project manager manages everything.  
  
Agile product owner is charged what features and requirement are involved and so on. And another role is scrum master who is charged to track and assign tasks.
10. What is the role of QA in agile approach? Has the QA authority to stop development teams, not adhering to processes?  
QA has no difference responsibility between the two approaches. QA is charged in all the quality.
11. In some organizations, team members move together to work (e.g. in Huawei).  
What are the benefits of doing so? What are the negative effects?  
The same in the company. It is easier to communicate, for example, to find his seat and ask whether it is good time to ask which takes much more time.  
The negative is less private. If some teams are active and talkative, it is bothering for others.
12. How important are clear requirements in traditional SW development? In agile development?  
Waterfall development approach needs clearer requirement. If it is wrong, it affects more in SW development.
13. How important are effective feedback and communication tools in traditional SW development? In agile development? Is there a difference between the tools used?  
No relation between the two approaches.

Communication tools: face to face is best but use it or not because the team is global and financial problem not because which approach.

- Migration from traditional SW development to agile

14. What is the main difficulty in migrating from traditional SW development to agile approach?

Some teams are not fit for agile approach, for example, it is difficulty to divide the feature into smaller iteration.

15. What is the main change in your team since you adopted agile?

There is more review happen which make the tasks in all the team more clearly to everyone.

16. What is your suggestion of process optimization for agile?

Very clear definition roles and responsibility, especially for roles related to project management.

17. In your opinion, which requirements do agile as a work form put on

- a. The organization? Clear definition roles and responsibility.
- b. The development process? Follow agile approach discipline.
- c. The team members? Everyone needs to be more mature, more experienced.

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