

Usage of Kanban in Software Companies

An empirical study on motivation, benefits and challenges

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Abstract— There is a growing interest in applying Kanban in software development to reap the proclaimed benefits presented in the literature. The goal of this paper is to provide up-to-date knowledge of the current state of Kanban usage in software companies, regarding the motivation for using it as well as the benefits obtained and challenges faced in its adoption. In addition, we investigate how the challenges identified in the study can be addressed. For this purpose, an empirical study was conducted consisting of a survey and complementing thematic interviews. The empirical study was carried out in November-December 2013 within large Finnish software companies, which extensively use Agile and Lean approaches. The obtained results are largely in line with the findings of earlier research reported in the literature. Generally, the experiences of using Kanban are rather positive; however, challenges in adoption identified include a lack of specialised training and usage experience, and a too traditional organisational culture.

Keywords- Kanban; Lean; Agile; Software development.

I. INTRODUCTION

Today, Agile and Lean are used in most global industries including the software industry. The Lean approach has been developed and found successful in the manufacturing industry [1], and it was later adopted by the software engineering field.

The key trait of Lean is to eliminate all kinds of waste from the development. Poppendieck and Poppendieck [1] transformed Lean manufacturing principles for use in the software engineering field. In order to eliminate and manage waste Poppendieck and Poppendieck [1] proposed the following set of principles:

- Build quality in
- Create knowledge
- Defer commitment
- Deliver fast
- Respect people
- Optimise the whole

In software development, all things that do not produce value for the customer are considered “waste”. For example, partially completed work, extra processes, extra features, task switching and defects are also considered a waste [1].

Kanban is one way to execute Lean thinking, used for decades in managing production operations at Toyota [2]. It is the most recent addition to the Agile and Lean software development. In recent years, Kanban has become more popular in software development. A strong practitioner-driven movement emerged to supporting it [3][4]. Currently, Kanban method is being increasingly adopted to complement Scrum and other Agile methods in software processes.

Despite the recent increasing interest in Kanban among practitioners, existing scientific literature addresses it infrequently in the context of software development. Only a few studies on Kanban usage, how it is carried out in practice and its effects in software development have been published [5]. With the goal of providing up-to-date results that can be utilised by organisations implementing or planning to implement Agile and Lean methods, we have conducted an empirical study on the current state of Kanban usage in software companies. We carried out the study in the Cloud software and Need for Speed program, which is a large Finnish national program aiming at improving the competitive position of the Finnish software intensive industry in global markets by pioneering the building of new cloud business models, a Lean software enterprise model and open cloud software infrastructure. The program involves more than 30 research organisations and enterprises, including most of the major Finnish software companies that are actively using and researching Agile and Lean [5]. We conducted a survey and a set of interviews addressing the following questions:

- Why is Kanban used in software companies?
- What are the benefits, of using Kanban?
- What are the challenges in adopting Kanban and its solutions?

The rest of the paper is structured as follows: Section II reviews the current literature on Kanban usage. Section III describes the research setting, including the process for collecting the empirical data as well as the design of the survey and interviews. Section IV present the results of the study and compares them with the findings from earlier research. Finally, Section V concludes the paper summarising the results and discussing the limitations of the study.

II. KANBAN BACKGROUND

Kanban, developed by Taiichi Ohno, was introduced in the Japanese manufacturing industry in the 1950s. Kanban literally means signboard or visualisation of inventory used in the scheduling system for just in time (JIT) production. The idea behind the development of Kanban was to find a system to maintain and improve production. It is a flow control mechanism for pull-driven JIT production, in which the upstream processing activities are triggered by the downstream process demand signals [2][7]. Kanban runs the production system as a whole, and it has proven an excellent way of promoting improvement. It was successfully used in practice by Toyota. The basic idea behind Kanban usage is to execute Lean thinking in practice; however Lean is more than Kanban [7][8][9].

Present-day understanding of Lean and Kanban in software development is largely driven by practitioner’s books [1][6][10]. The Lean and Kanban principles appear to be largely overlapping, reflecting the same grounding. Table I shows the Lean software development principles [1] and Kanban principles [10], which are known to the Agile community.

TABLE I. LEAN AND KANBAN PRINCIPLES

Lean software development principles [1]	Kanban Principles [9]
Eliminate waste Build quality in Create knowledge Defer commitment Deliver fast Respect people Optimise the whole	Visualise the workflow Limit work in progress Measure and manage flow Make process policies explicit Improve collaboratively

Kanban in software development originated in 2004, when David J. Anderson [10] was assisting a small IT team at Microsoft that was operating poorly. Anderson [10] introduced Kanban to the team to help the team members visualise their work and put limits on their work in progress (WIP). The motivation behind visualisation and limiting WIP was to identify the constraints of the process and focus on a single item at a time. This technique promotes the pull approach. In traditional software development, the work items are given i.e. “pushed” to each team member, who are then instructed to finish as many of them as quickly as possible. The traditional development work is in the form of a chain in which one team member’s work item is handed over to another i.e. from developer to tester. This causes delays in the whole process when the next member in the line is overloaded or has a problem with his/her work. Kanban works in an alternative way. Instead of pushing work items, it promotes a pull system. Each member of a team has one item to work on at a time. When he/she finishes it, he/she will automatically pull the next item to work on.

In brief, Kanban aims to provide visibility to the software development process, communicate priorities and highlight bottlenecks [5], which results in a constant flow of releasing work items to the customers, as the developers focus only on those few items at a given time [6]. Figure 1 shows the

typical structure of a Kanban board and its principles in action.

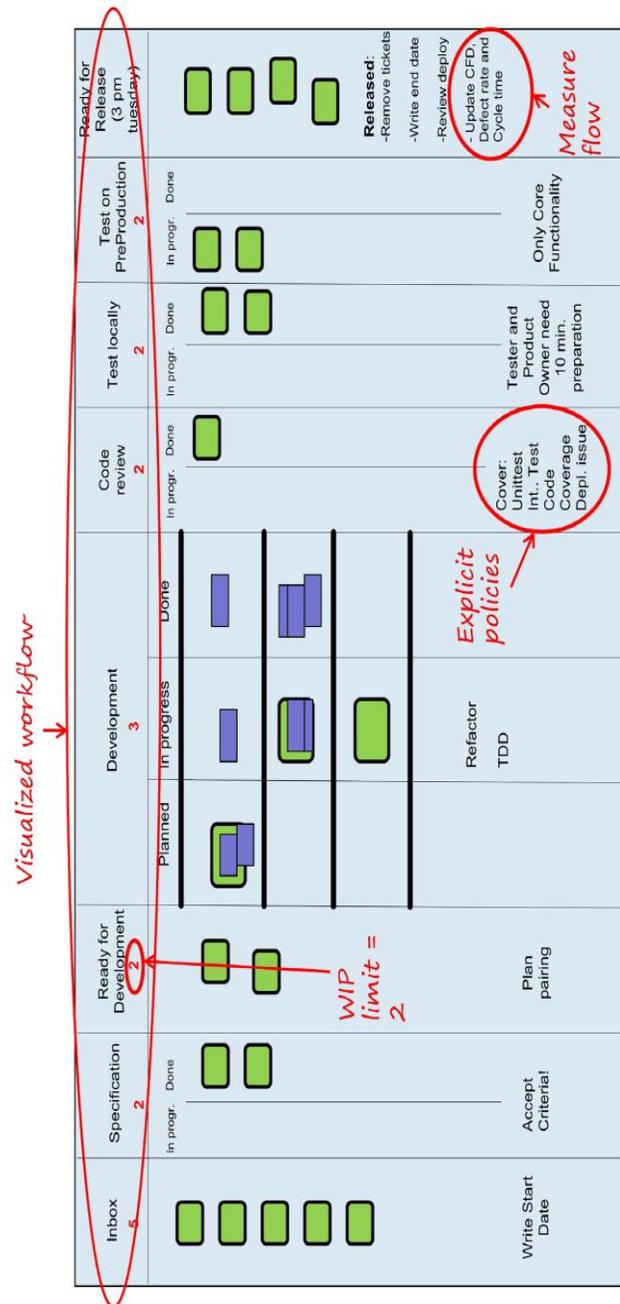


Figure 1. Kanban board and principles in action [12]

The Kanban method in software development drives project teams to visualise the workflow, limit WIP at each workflow stage, and measure the cycle time [11]. The key motivation for the usage of Kanban is to focus on flow and the absence of obligatory iterations.

Kanban implementation has been relatively successful in the manufacturing industry yielding various advantages. Successful histories of the manufacturing industry have convinced software engineers to adopt this approach; thus,

the adoption of Kanban in software development has gained strong practitioner-driven support.

The proliferation of the Kanban method in software engineering boomed after the first books were published [10][12]. The most popular of these books include David J. Anderson's "Kanban" [10], in which he introduced the concept of Kanban in systems and software development, and Corey Lada's "Scrumban" [12], in which he discusses the fusion of Scrum and Kanban.

A recent systematic literature review [6] on Kanban in software development shows certain benefits and challenges in the adoption of Kanban. The main benefits of using Kanban in software development are a better understanding of the whole process, improved quality of team communication and coordination with stakeholders, and better coverage of customer satisfaction [14][15][16]. According to [17], the use of Kanban in software development improved the lead-time to deliver software by 37%, the consistency of delivery rose by 47%, and defects reported by customers fell by 24% compared to the previously used Agile method. Because of the WIP limit, highest priority items are pulled to optimise value, resulting in improved customer satisfaction [14][15][17]. As Kanban does not involve any fixed plans, it helps to avoid requirement cramming.

According to [6], Kanban needs other supporting Agile practices to work effectively. However, this mixed approach has been problematic for many teams [18]. Motivating staff members to use Kanban has been challenging because of organisational culture and the stickiness of people to other familiar software development methodologies [14][16][18]. Additionally, a lack of specialised skills and training, and the misunderstanding of core principles have been reasons for failing to adopt Kanban [14][16][18].

III. RESEARCH SETTING

Empirical data was collected from software companies participating in a Cloud Software program. The empirical study was carried out in two stages. In the first stage, the Kanban usage survey was conducted among the participant companies' representatives. The survey was conducted in November 2013 using an Internet survey tool. The survey included questions on Kanban usage, motivation to use it, benefits achieved through its usage, and challenges faced in the Kanban adoption stage.

In the second stage, the survey results were complemented with semi-structured thematic interviews in December 2013, for which the survey respondents volunteered. The themes in the interview consisted of benefits and challenges of Kanban usage and methods to address and tackle the faced challenges.

In the first stage, an Internet survey request was emailed to the company representatives to identify and rate the importance of their usage motivations, the benefits achieved and challenges faced, while adopting Kanban in their unit. A five-point scale was used to assess the rate. The survey was open for two weeks. During this time, 21 persons, representing 10 different large software intensive companies, responded to the survey.

In the second stage, eight managerial level company representatives were interviewed. The purpose of the interviews was to complement the survey results by discovering the interviewees' views on Kanban usage in their teams or units. The duration of the interviews varied between 60 and 90 minutes (average 70 minutes). All interviews were recorded and transcribed by the interviewers, and the transcriptions were checked by the interviewees to ensure consistency.

IV. RESULTS

This section presents the results of the Kanban usage survey and the thematic interviews. The results of the survey are compared with results of earlier studies on Kanban.

A. Survey results

Table II and Table III present the positions of the respondents in their organisations and the respondents' experiences in software development.

TABLE II. RESPONDENTS BACKGROUND

Positions	n
President/CEO/CTO/Director	1
Program Manager/R&D Manager	3
Project Manager/Product owner/Agile coach	7
Analyst/Developer/Designer	8
Consultant/Trainer	2
Total	21

TABLE III. EXPERIENCE IN SOFTWARE DEVELOPMENT

Years of experience	n	%
1-5	4	19
6-10	1	5
More than 10	16	76
Total	21	100

The respondents were working in various positions in their organisations. The main organisational roles of the respondents were mid-level management (project managers, program managers, agile coaches, and analysts), and 76% had more than 10 years of software development experience. The typical sizes of working teams in the respondents' organisational units are presented in Table IV below.

TABLE IV. TEAM SIZE

Team size	n	%
1-3	1	5
4-6	5	24
7-9	11	52
10-12	3	14
13 and above	1	5
Total	21	100

The teams mostly comprise less than 10 persons. Only one company has teams with more than 13 persons.

Of the respondents, 57% reported that Kanban was used in their organisation. Most of the organisations using Kanban

had been using it for more than one year. The respondents of these organisations considered themselves competent in their knowledge of Kanban.

The Kanban users were requested to identify and rate the importance of motivation factors, achieved benefits and faced challenges while adopting Kanban in their unit. The results are presented in Tables V–VII.

TABLE V. KANBAN USAGE MOTIVATION

Motivation for choosing Kanban	Mean	Median
To improve team communication	4.4	5
To reduce development cycle times & time-to-market	4.2	5
To improve development flow	4.1	4
To increase productivity	4.1	4
To create transparency within the organisation	3.8	4
To improve product and service quality	3.8	4
To improve understanding of the whole value stream	3.5	4
To improve process quality	3.5	4
To improve stakeholders' satisfaction	3.3	4
To remove excess activities	3.3	3
To increase the ability to adapt to changes in the business environment	3.8	3
To decrease development costs	2.9	3
To improve organisational learning	2.6	3
To improve the management of business/ product value	2.5	3
To improve customer understanding	2.6	2

The results in Table V show the highest motivation factors in Kanban adoption are to improve team communication, reduce development cycle times and time-to-market, improve development flow, increase productivity, and create transparency within the organisation (with means of 4 or higher). According to [11], Kanban usage is motivated by its adaptability, ease of management by visualising the progress, and driving team members to cooperate and communicate. The motivation factors for using Kanban in software processes are aligned with what Anderson explained [6][10].

The respondents were also requested to indicate the achieved benefits of using Kanban. Those benefits are presented in Table VI.

TABLE VI. ACHIEVED BENEFITS OF USING KANBAN

Achieved benefits	Mean	Median
Better visibility of work	4.9	5
Improved transparency of work	4.5	5
Improved communication	4.3	4
Better flow controls	4.2	4
Better focus on your work	4.1	4
Better control on WIP	4.0	4
Enhanced efficiency	3.9	4
Better understanding of the whole process	3.7	4
Help in building trust	3.6	4
Help in predictability	3.6	4
Decrease in context switching	3.5	3
Enhanced quality	3.1	3
Assist leadership in strategic decision making	2.7	3

Table VI shows that the achieved benefits of using Kanban are similar to those in the literature. Better visibility, improved transparency of work and communication, better control of flow and WIP were the most common benefits experienced by the respondents of the survey. Such positive results correspond to the literature [4][6][7][10][12][19].

The results in Table VII show the order of significance of various challenges in Kanban adoption.

TABLE VII. CHALLENGES IN KANBAN ADOPTION

Challenges	Mean	Median
Lack of experience with the Kanban method	4.0	4
Hard to manage WIP limit	3.9	4
Hard to select tasks according to priority	3.3	3
Organisational culture was too traditional	3.2	3
Lack of knowledge and specialised training	3.1	3
No clear vision/roadmap for product(s)	3.0	3
Team members tend to fall back on using old methods	2.9	3
Teams were lacking decision-making ability & authority	2.6	3
Lack of customer/supplier collaboration	2.5	3
Unwillingness of team to follow Kanban	2.5	2
Incomplete planning for Kanban method adoption	2.4	2
Lack of management sponsorship	2.4	3
Decreased predictability	2.4	3
Burden of communication between teams or with in team	2.3	3
Inappropriateness of existing Kanban technologies/tools	2.3	3
Lack of customer presence	2.3	3
Lack of support from the management	2.2	2
Customer was not ready for increased communication	2.2	2
Incompatibility of business domain with Kanban method	1.9	2

Lack of experience with Kanban is the main challenge in adopting Kanban. Other major challenges are the difficulty managing the WIP limit and selecting tasks according to priority. Organisational culture, no clear vision or roadmap for product and team members tending to fall back on using old methods are other challenges that software companies face when adopting Kanban. All these challenges could be linked to one challenge: a lack of knowledge and specialised training.

B. Interview results

In this section, the results obtained from the interviews are described. The results of the thematic interview analysis can be classified into three main themes: benefits obtained, challenges faced, and solutions to the challenges in Kanban usage.

1) Benefits obtained

All of the interviewees reported that Kanban works well in their teams. Referring to the achieved benefits claimed in the survey, one interviewee mentioned, *“In our company, this is the default way of working in any team that has any support or operations type of work when the next two weeks just cannot be planned beforehand. I see the enhanced customer feedback loop as one of the main benefits”*.

In line with the survey results regarding Kanban effects on their teamwork, an interviewee elaborated, *“Kanban works perfectly; the team can see the bigger picture of work and it brings realism to the work. Many tasks become clearer, especially high priority ones, and easier to justify, and we always find the balance between the demand and the capability. The team analysed their performance and velocity quite well, they understand the WIP limit and now they avoid taking too much work on”*.

To explain the benefits of Kanban and the areas of successful implementation, one interviewee mentioned that in their “testing team”, *“Kanban is beneficial because it puts limits on various things in each release and makes certain things visible which were not visible before Kanban adoption. Kanban makes work visible inside and outside the team and visualises customer needs. It helps in collecting new kinds of issues and a good example is the test area”*.

All the interviewees reported that, with Kanban usage, the essence of collaborative work is visible and more and more work is collectively completed in the development team. Interviewees reported, *“Kanban helps to make bonds in teams and to start getting things done successfully. Kanban helps those team members who are in trouble to get the work done collaboratively”*. Additionally, *“the team starts looking to where more and more things are actually waiting, and they start identifying root causes of why the flow is not working and make those blockers visible. To maintain the flow, the whole team starts solving them”*. Furthermore, one interviewee mentioned, *“Kanban helps with flexibility when organising the work and efficiency, and so on”*.

2) Challenges in Kanban usage

One of the bigger challenges found in the survey was the lack of experience using Kanban, which leads to some other challenges, e.g., difficulty managing the WIP limit and selecting tasks according to priority. An interviewee explained these challenges in this way: *“In a company, not all business lines and top level management are familiar with Kanban. There are a few people who have knowledge but they also like to build their confidence to use the new Kanban approach. So, there is much resistance to change. The company lacks awareness about the existing mind-set issue. For example, for us, the release cycle is quite big; we are dealing with a huge requirement. In such a scenario, we need confidence that this can be done and delivered efficiently with this new Kanban thing. Nobody is willing to take the risk and start doing things the Kanban way. Everyone in the company knows that if we lose one release, we are out of the market, which means there's no company. The risk level is clear. It makes you feel safer to stay with what you already have.”*

Additionally, an interviewee agreed and reported *“The lack of training is a big challenge while using Kanban at both the portfolio and team level. The purpose and theory behind Kanban is misunderstood. The common question is raised, what is the problem we are trying to solve with Kanban?”* That is the reason why, when Kanban was implemented in the work without proper knowledge and training, an interviewee mentioned, *“Many times you don't actually necessarily look at the flow (of inflow and outflow of things) and the team don't actually use the WIP limits. When asking from where these WIP limits come, they guessed that the WIP limits were set without any planning.”*

Apart from knowledge and proper training, mind-set is equally important for the adoption of Kanban. With limited knowledge and experience, it is hard to motivate and change people's mind-sets to work using the Kanban method. This is also a reason for teams reverting to their previous way of working. Most of the companies interviewed agreed on this issue. One interviewee mentioned, *“People always want to stick with the way they work; it requires a lot of effort to change the mind-set”*.

3) Solutions to challenges

The interviewees were asked what kind of solution they would propose or use to tackle the challenges they are facing in adopting Kanban. From the study, the following solutions were obtained to cope with the challenges:

- Provide proper training to the teams.
- Allow teams to experiment or pilot the method and get some experience using Kanban. Such piloting helps to learn the Kanban way of working by doing.
- Educating people help to change the mind-set so that the resistance to change will be easier to tackle. When people are educated and the expected benefits of Kanban are communicated, they will more likely be convinced to adopt it in their work.

- Commitment and awareness is required from the top-level management down through the company.

V. CONCLUSION

The goal of this study was to investigate the adoption and usage of Kanban in large software companies. The study was conducted in large multinational Finnish companies that have premises in several other countries. Using a survey and thematic interviews, the study aimed to analyse the motivations of Kanban usage, the obtained benefits, and the faced challenges when adopting Kanban. Additionally, solutions to the challenges were identified.

In this study, the identified main motivation factors for adopting Kanban were to improve team communication, and development flow, reduce time to reach the market, increase productivity, and create transparency in organisation. Furthermore, the most common achieved benefits of using Kanban were better visibility of work, improved transparency of work and communication and better control of flow.

Regarding the challenges faced, the most common one is lack of experience with Kanban, which makes it hard for teams to manage WIP limits and select tasks according to priority. Furthermore the traditional culture of the organisation was reported a challenge in the adoption of Kanban. Because of these challenges, team members tend to fall back on using old methods or previous ways of working. The literature and the results indicated that with proper training, the challenges could be handled to some extent.

The study subjects were representatives of large Finnish software companies, which provide a good general view of Kanban usage in advanced software companies utilising Agile and Lean approaches. However, the subjects of this study represent only a limited view of the participant companies. Therefore, to study more comprehensively the usage of Kanban throughout organisations, more extensive research involving all teams using Kanban in the organisation should be conducted. Future investigation would also be needed to gain a better understanding of the application of Kanban at different levels in the organisations, e.g., at the portfolio and team levels.

Despite a limited view of the participant companies, this study provides valuable descriptive information about the contemporary state of Kanban usage in software companies. The contributions of this paper are 1) up-to-date results on the current state of Kanban usage, based on first-hand industry insight on why Kanban is being used in software development as well as its benefits and challenges, 2) the first explorative study analysing the Kanban usage in software development, and 3) grounding for future research based on the identified main benefits and challenges on using Kanban.

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