

Antecedents To Achieve Kanban Optimum Benefits In Software Companies

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Abstract— In 2004, Kanban successfully entered the Agile and Lean realm. Since then, software companies have been increasingly using it in software development teams. The goal of this study is to perform an empirical investigation on antecedents considered as important for achieving optimum benefits of Kanban use and to discuss the practical implications of the findings. We conducted an online survey with software professionals from the *Lean Software Development* LinkedIn community to investigate the importance of antecedents of using Kanban for achieving optimum benefits. Our study reveals that subjective norm, organizational support, ease of use, Kanban use experience and training are the antecedents for achieving expected benefits of Kanban. The potential benefits of Kanban use can only be realized when the key antecedents are not only identified, but also infused across an organization. When managing the transition to or using Kanban, practitioners need to adapt their strategies on the extent of various antecedents, a few identified in this study.

Keywords- Agile; Lean; Kanban; Software Development.

I. INTRODUCTION

It has been more than ten years since the use of Kanban in software engineering was suggested. During the last decade, there has been significant adoption of Kanban in domains such as aeronautics, healthcare, retail clothing, human resources, and software development [1]. Kanban was emerged as part of Toyota Production System. The idea was to work effectively under pressure and market situation. Kanban literal meaning is signboard [1].

Toyota, used Kanban due to three reasons: reduction in information processing cost, rapid and precise acquisition of facts, and limiting surplus capacity of preceding shops or stages [10]. In 2004, David Anderson introduced Kanban to a software development team in Microsoft. “Kanban (capital K) is an evolutionary change method that utilizes a kanban (small k) pull system, visualization, and other tools to catalyse the introduction of Lean ideas... the process is evolutionary and incremental” [1]. Anderson identified five key properties, which Boeg called principles: Visualise the workflow, Limit Work In Progress, Measure and manage flow, Make process policies explicit, Improve collaboratively (using models and the scientific method) [1].

The annual State of Agile VersionOne [3] reported that from “2016 to 2017 the use of Kanban grew from 50% to 65% in software companies”. The most recent systematic mapping study on applying Kanban in software engineering reports a variety of benefits with the use of Kanban in their work [1]. The study distilled various Kanban benefits under three broad categories [1]:

- Process - Improved visibility and transparency, Better control of project activities and tasks, Identification of impediments to flow, Improved prioritisation of products and tasks.
- People - Improved communication and collaboration, Improved team motivation, Improved team building and cohesion, Increased customer satisfaction.
- Organization - Promotion culture of continuous learning and strategic alignment.

These benefits are achieved by using Kanban in two broad knowledge areas: Software engineering process management and economics [1]. Despite the positive evidence supporting the success of Kanban in software organizations, the industry is still facing recurring problems (with, e.g., customer satisfaction, organizational culture or poor knowledge management) [1]. To achieve the optimum benefits of agile and lean approaches there is lack of sufficient theoretical foundations. However, a few studies have focused on a set of potential factors that impact perceived success or ‘acceptance’ of agile practices where success is measured using outcomes such as quality, time, and cost [4], agile software solution framework [6] and assimilation of practices [7]. The existing suggested various antecedents which contribute to the effective use of Agile methods (e.g., support from organization, positive change culture, formal training and developers’ perception about the difficulty or ease of use regarding method, practice or tool) [1][8][9][11]-[13].

There is a need for detailed studies on agile software development to provide credible advice to software companies regarding its use [13]. Kanban also comes under the agile realm and is still in its infancy in software engineering. Currently, there is lack of empirical evidence regarding Kanban antecedents and use benefits. It is important to investigate the importance of organizational support, training, experience, subjective norms, and

perceived ease of use against Kanban claimed benefits. Such evidence will help in the generalization of results, and in confirming or refuting anecdotal evidence. Further, it will provide practical guidelines that can assist software practitioners regarding decisions in their selection of software development approaches. The goal of this study is to investigate various antecedents considered important for achieving optimum benefits of Kanban use.

RQ1. What antecedents make software industry achieve the optimum benefits of Kanban from its use?

To answer RQ1, we conducted a web survey in the summer of 2017, targeted LinkedIn practitioners' group: "Lean Software Development" - one of the largest LinkedIn communities of professionals whose members are using and researching Lean and Kanban.

The paper is organized as follows. Section II elaborates conceptualization of the antecedents. Section III describes the survey design, while Section IV presents the methods used for analysing the data. Section V presents the results before moving to discussion about the findings in Section VI. Section VII presents the threats to validity and, Section VIII concludes the paper with recommendations for practice and researchers.

II. ANTECEDENTS CONCEPTUALIZATION

In general, software and system development methodologies are adaptable. Senapathi and Srinivasan [11] claim that agile methods lack a strong theoretical base. The information systems literature extensively tested models, e.g., the diffusion of innovation, planned behaviour, technology acceptance model and information systems implementation research [11]. These models generated interest in the agile research community [7][11]. To investigate software developers' acceptance of methodologies, Riemenschneider et al. [8] compare the existing five theoretical models. Dybå et al. [12] added the construct of organizational support to the four constructs presented by Riemenschneider et al. [8] i.e., perceived ease of use, perceived compatibility, perceived usefulness and subjective norms. Similarly, Senapathi and Srinivasan [11] identify other constructs pertinent to post-adoptive usage of agile practices, namely relative advantage, team attitude and technical competence, championing, and top management support. Ahmad et al. [9] discussed aspects that Kanban practitioners perceived to be important (i.e., organizational support and social influence). We took Dybå et al. [12] model factor as baseline for our study:

Organizational support is the extent to which change agents promote or support efforts, as a factor in explaining an innovation's (e.g., Kanban as a new working method) rate of adoption [9]. Coaching and support is a key to the success of facilitating and sustaining organizational learning and knowledge creation. Iivari and Huisman [16] identified that organizational culture contributes in the espousal of software development methodologies. Kaemar [17] reported

that, diffusion of software process effect could be arbitrated by perceived organizational usefulness. Therefore, we believe, Kanban benefits can be achieved by providing organizational support.

Training, in the form of formal training, of any methodology is important for its successful implementation. Chan and Thong [4] exhibit that training has a positive effect on individuals' beliefs and perceived compatibility of an innovation. In Agile methodologies, training and coaching play an important role in the successful use and reap of the benefits [4]. In the light of existing studies [21][22], formal training plays an important role in the use and successful implementation of any methodology. Thus, we believe that Kanban benefits can be reaped by providing formal training.

Experience means individuals with the attitude and experience to embrace new practices (e.g., Agile) easily and fast, whereas high level of team experience contributes to increased productivity [23]. High level of experience, technical knowledge and self-organizing working style within a team affect the successful usage of agile practices. Experience can be considered as a positive or negative aspect in using agile methods and practices. Salo and Abrahamsson [24] present that experienced users of agile methods and practices have positive views about its usefulness. Laanti et al. [5] found a positive connotation between the length of agile experience and attitudes towards its usefulness. Whereas Vijayarathy and Turk [2] found no evidence.

Subjective norms refer to a person's perception that most people who are important to him/her think he/she should or should not perform the behaviour in question [8][20]. The software companies are encouraging their developers to work collaboratively in teams. To some extent, teamwork creates social pressure on individuals. Subjective norms are significant in methodologies acceptance [4][8] while a few found it insignificant [12][20]. Therefore, we can say that, the stronger subjective norms, the more likely practitioners reap Kanban use benefits.

Ease of use can be described as "The degree to which a person believes that using a particular system would be free of effort" Davis [19]. It explains whether a method or tool is easy to use or not, and how they are perceived in relation to the claimed benefits. According to Kaemar et al. [17] the perceptions of development methodology challenges are negatively associated with perceived ease of use. Riemenschneider et al. [8] in turn, claim that ease of use construct has insignificant role in the acceptance of software methodologies. However, other studies recur that ease of use is a significant determinant of adoption behaviour [9][12][19]. Therefore, we believe Kanban's ease to use is an important aspect in achieving the optimum Kanban benefits.

Self-efficacy is about "belief in one's capabilities to organize and execute the courses of action required to produce given attainments" [18]. Self-efficacy is to predict

positive attitude towards a specific job, technology, training proficiency and job performance [18]. Therefore, we believe self-efficacy is an important aspect in achieving the optimum Kanban benefits.

III. SURVEY DESIGN AND DATA COLLECTION

To reach a global population of Kanban practitioners, we sent out a web survey to “Agile and Lean Software Development” community of practitioners in LinkedIn. At the time of the study, the population of “Agile and Lean Software Development” was about 138,460 software practitioners.

Prior to the actual survey launch, we piloted and pre-tested the survey with four relevant field researchers from University of Oulu and five software professionals from the software industry. In the light of the feedback, received from both the researchers and software professionals, we revised and clarified the questions and wordings of the statements accordingly. The survey welcome page provided a clear description of the study purpose and researchers information. The survey remained open for two months (June and July 2017) and had three sections:

- Background information, Kanban use experience and type of Kanban training attended.
- Benefits of using Kanban: We based the questions on literature [1] and asked the respondents to rate the significance of each Kanban benefit for their organization using a five-point Likert-type scale (from 1 strongly disagree to 5 strongly agree). The respondent can also explain the obtained Kanban benefits in more detail, in the form of open-ended questions.
- Antecedents for achieving optimum Kanban benefits: Similarly, with the help of literature [9][20][19], we adapted the questions for the antecedents. For rating, we used a five-point Likert-type scale.

IV. DATA ANALYSIS

In our analysis, we divided the respondents into groups with respect to their reported level of received organizational support, perception of ease of use, training, subjective norm, and experience. These groups were compared to find out whether there are differences in the perceived benefits between the groups. Such comparison provides insight into relationships between perceived benefits of Kanban usage and its antecedents.

Comparisons were conducted through Student's t-test, Welch's t-test, analysis of variance or Welch's ANOVA, depending on the number of groups to be compared and whether the assumption of group-wise variances' homogeneity was met or not. These tests help to investigate whether there are statistically significant differences with respect to the perceived benefits between the groups. We carried out our analysis with the significance level (α) of 0.05, i.e., we decided whether to reject the null hypotheses

(no differences between the groups) with the risk level of 5 %.

V. RESULTS

The collected data set included 67 responses. Majority of the respondents were from organizations developing software (n=45), while the rest were working in IT services (n=14), telecommunication (n=2) and hardware manufacturing (n=6).

We categorized all the organizations reported by the respondents, based on small and medium-sized enterprises. Most respondents were working in a small organization (n=30, number of employees between 10–49), the rest worked in large organizations (n=17, more than 250 employees) and middle size organizations (n=14, number of employees between 50–249). Only 6 respondents were from start-up company. Respondents' main organizational roles involved first level management (n=20) and development teams (n=17). Other reported positions were middle management (n=16) and top-level management (n=7). The remaining 7 roles were operation & support staff.

Almost all the respondents understood Kanban. The majority (n=35) of the respondents considered themselves as advanced beginners using Kanban in a local project. However, having said that, only 5 respondents purely used it for distributed projects. Table 1 shows, how the respondents rated the significance of Kanban use benefits and a few explained more in open-ended questions.

The top three benefits are improved visibility of work, reduction in work in progress and improved development flow; which are the key pillars of Kanban. It was also highlighted that Kanban helps to “visualize tasks in progress” and “highlight the bottlenecks” in the flow as well as has the “ability to analyse outliers within the standard deviation of cycle or lead time, Kanban allows for “just-in-time prioritization” and has “moved the team from a sprint to finish coding to continually deliver excellent software”.

TABLE I. RESPONDENTS RATE KANBAN BENEFITS

Kanban benefits	Average
Improved visibility of work	3.67
Reduction in work in progress	3.15
Improved development flow	3.00
Faster time to delivery	2.88
Improved team collaboration	2.63
Improved understanding of whole value stream	2.58
Improved team communication	2.51
Improved team motivation	2.45
Increased productivity	2.42
Reduced cycle time	2.42
Better meeting of customer needs	2.27
Improved software quality	2.21
Enhance customer satisfaction	2.25

Table II shows the internal consistency of antecedent factors using Cronbach’s alpha [15]. The items in each variable are grouped together for statistical tests. Cronbach Alphas value for all the items varied between 0.64 and 0.83, suggesting a relatively high internal consistency, based on the 0.7 threshold recommended by Nunnally [15].

Cronbach’s alpha was below 0.7 only for OS2 variable that measured the respondents’ perceived availability of written instructions on Kanban in their organizations. However, the overall OS internal consistency is 0.83. With respect to the SN and PEOU factors, we did not identify any items whose removal would have increased the internal consistency [15]. Based on the high internal consistency of these items, we calculated the sum variables of all items for each factor and used those for statistical tests in subsequent stages of the study.

TABLE II. CRONBACH’S ALPHAS

Factors	Variables	Cronbach’s alpha (α)	
Organizational Support (OS)	OS1	0.83	0.83
	OS2	0.64	
	OS3	0.83	
Subjective Norms (SN)	SN1	0.79	0.88
	SN2	0.79	
Perceived Ease of Use (PEOU)	PEOU1	0.82	0.85
	PEOU2	0.82	
	PEOU3	0.79	
	PEOU4	0.82	

Organizational support: The respondents were divided into two groups based on the value of the organizational support sum variable (the mean of separate items): respondents provided with no support or weak support only (sum variable value less than 3), and respondents with moderate or strong support (sum variable value 3 or higher). Using Student’s t-test, a statistically significant difference was found between the groups ($p=0.000$) with the means of the perceived benefits presented in Table III. The PS mean was higher in the group with moderate or strong support.

TABLE III. MEANS OF PERCEIVED BENEFITS WITH RESPECT TO OS

Group (n=67)	Mean of perceived benefits
No support or weak support (n=53)	2.363
Moderate or strong support (n=14)	3.699

We analysed the respondents’ organizational position against the Kanban perceived benefits. The respondents were divided into three groups based on their organizational position: management (including top-level management, middle level management, and first level management), support (including IT/operations/support staff, and sales/marketing personnel) and development. Using ANOVA, a statistically significant difference was found

between the groups ($p=0.016$) with the means of the perceived benefits shown in Table IV. The mean for perceived benefits was lowest in the Development group and highest in the Management group.

TABLE IV. MEANS OF PERCEIVED BENEFITS WITH RESPECT TO ORGANISATIONAL POSITION

Group (n=67)	Mean of perceived benefits
Management (n=43)	2.890
Support (n=7)	2.388
Development (n=17)	2.118

The result indicates that the respondents with the organizational position *management* perceive benefits of Kanban usage higher than the ones with the organizational positions *development* and *support*. Additionally, we investigated association between organizational position and organizational support. In this way, we aimed to find out whether the support received by the respondents’ varied among the organizational position groups. Table V shows cross tabulation of these variables. Based on the calculation of Pearson’s Chi-Square test of independence, the differences in organizational support between the organizational position groups were statistically significant ($\chi^2=6.019$, $df=2$, $p=0.049$). The cross tabulation shows, none of the respondents with the organizational position *development* reported that they had received moderate or strong support.

TABLE V. CROSS TABULATION OF POSITION AND OS

Organizational support (N=67)	Position		
	Management	Development	Support
No support or weak support provided	31	17	5
Moderate or strong support provided	12	0	2

Ease of use: The respondents were divided into two groups based on the value of the perceived ease of use sum variable: respondents with lower level of perceived ease of use (sum variable value less than three), and respondents with higher level of perceived ease of use (sum variable value three or higher). Using Welch’s two sample t-test, a statistically significant difference was found between the groups ($p=0.000$) with the means of perceived benefits presented in Table VI. The mean of perceived benefits was higher in the group with higher perceived ease of use.

TABLE VI. MEANS OF PERCEIVED BENEFITS WITH RESPECT TO PEOU

Group (n=67)	Mean of perceived benefits
Lower perceived ease of use (n=41)	2.099
Higher perceived ease of use (n=26)	3.497

Kanban training: The respondents were divided into two groups based on their Kanban training, i.e., respondents with no training or self-studying, and respondents with formal training (including peer mentoring, and education

with the duration of at least one day). Using Student's t-test, no statistically significant difference was found between the groups with respect to their perceived benefits ($p=0.854$, the means for the groups with No Kanban training or self-studying and with Formal Kanban training as 2.620 and 2.665, respectively).

In order to obtain better insight into the dependence of the perceived benefits on Kanban competence, we investigated Kanban knowledge against benefits. We divided respondents into two groups based on their Kanban knowledge: respondents with lower knowledge (assessed themselves as advanced beginners), and respondents with higher knowledge (assessed as competent or experts). Using Welch's two sample t-test, a statistically significant difference ($p=0.000$) was found between the groups with the means of the perceived benefits. The mean of perceived benefits was higher in the group with the higher knowledge.

TABLE VII. MEANS OF PERCEIVED BENEFITS WITH RESPECT TO KANBAN TRAINING

Group (n=67)	Mean of perceived benefits
No training or self-studying (n=35)	2.620
Formal training (n=32)	2.665

Further, we investigated the association between Kanban training and Kanban knowledge. Pearson's Chi-Square test of independence indicated that there is a statistically significant association between the variables ($\chi^2=7.81$, $df=1$, $p=0.005$). Although our analysis does not indicate a dependence between Kanban training and perceived benefits, there still seems to be a relation of some sort between Kanban competence and perceived benefits. As expected, respondents' Kanban knowledge was also dependent on their length of experience in Kanban usage as a statistically significant association was observed between these variables ($\chi^2=24.396$, $df=2$, $p=0.000$).

TABLE VIII. MEANS OF PERCEIVED BENEFITS WITH RESPECT TO KANBAN KNOWLEDGE (N=67)

Group	Mean of perceived benefits
Lower knowledge (n=40)	2.170
Higher knowledge (n=27)	3.341

Subjective norms: The respondents were divided into two groups based on the value of subjective norms sum variable: the respondents with lower level of subjective norms (sum variable value less than three), and the respondents with higher level of subjective norms of use (sum variable value three or higher). Using Student's t-test, a statistically significant difference was found between the groups ($p=0.000$) with the means of the perceived benefits presented in Table IX. The mean of perceived benefits was higher in the group with higher subjective norms.

TABLE IX. MEANS OF PERCEIVED BENEFITS WITH RESPECT TO SUBJECTIVE NORMS (N=67)

Group	Mean of perceived benefits
Lower (n=43) subjective norms	2.289
Higher (n=24) subjective norms	3.274

Kanban experience: The respondents were divided into three groups based on their Kanban experience: respondents with short experience (one year or less), moderate experience (two years or less), long experience (more than two years; in practice, up to five years). Using ANOVA, a statistically significant difference ($p=0.002$) was found between the groups with the means of the perceived benefits presented in Table X. Perceived benefits tend to increase along increased Kanban experience.

TABLE X. MEANS OF PERCEIVED BENEFITS WITH RESPECT TO KANBAN EXPERIENCE (N=67)

Group	Mean of perceived benefits
Short experience (n=27)	2.35
Moderate experience (n=24)	2.47
Long experience (n=16)	3.38

VI. DISCUSSION

A quantitative survey was performed to investigate antecedents, which help to achieve optimum Kanban use benefits. The study shows that Kanban practitioners experienced various benefits which are claimed in the existing literature, i.e., enhanced visibility of tasks, limit the work in progress at given time, smoothly develop and deliver various tasks continuously. For example, the visibility of various tasks improves team motivation, communication and collaboration.

The ease of use of any method and tool is important for achieving positive effects. Ease of use is an important antecedent for achieving optimum benefits of Kanban. The ease of use is significant to CASE tool usage [21]. Previous studies support that learning and using software development methods or tools does not require much of mental efforts [6][22][20]. In this study, perceived benefits seem to depend on ease of use of Kanban. Therefore, it should be considered that how to make Kanban use easier. The teams need to be free, in order to select the type of Kanban board (physical or virtual) [1][9].

When choosing and adopting to use any new tool, method or process "software professionals can be expected to be motivated by others who are important to them and whose opinions they value" [2]. Our findings highlight that perceived Kanban benefits depend on the level of subjective norms, and the level of perceived benefits tends to increase along with the increased subjective norms. The existing studies support the role of subjective norm in the prediction of innovation use among individuals [2]. Kanban experience

has positive relationships with the perceived benefits. The perceived benefits tend to increase along increased Kanban experience. This suggests that with the passage of time, practitioners get experience using Kanban and achieve the optimum benefits which are claimed in existing literature [8][20].

The organizational support is a highly significant antecedent of Kanban perceived benefits. This is also in accordance with prior studies of Kanban use, development processes and software engineering methodologies [1][8][11]. Organizational support should be provided throughout the departments to make Kanban adoption more efficient. Management support is important in the decision of adopting a new technique for eliciting user requirements. A recent systematic mapping study [1] suggested that training and allowing teams to experiment with Kanban in a specific context is a type organizational support. Our findings regarding the dependence between Kanban training and perceived benefits are somehow ambiguous. Specific attention is required, when about the way training is carried out; in order to provide the personnel with skills that really promote their Kanban learning and competence. The organizations provide customized training to various groups (e.g., development or management) and allow them to experiment and adopt Kanban principles based on their own requirements [20]. Studies support that organizational support (aka. training and consultation), play significant role in the use of Agile methodologies including Kanban [4][9].

VII. THREATS TO VALIDITY

We followed the guidelines for threats to validity presented by Runeson and Höst [14]. A common threat to web surveys is that questions might be misunderstood. To handle this threat, we piloted the survey with five researchers and four industry experts. After piloting, we rephrased a few survey questions to provide more clarity. Additionally, we designed survey questions using existing literature. Several questions were used in parallel for measuring many of the studied variables. As part of internal validity, a critical point is need to be taken in consideration that, this study is exploratory in nature and we are not empirically validating any model. We expect that there could be many additional factors, which could affect the actual use of Kanban.

We distributed web survey on LinkedIn, which is prone to external validity threat (i.e., the general applicability of the results) as the sample size was relatively small (n=67). However, the survey was conducted with the global population of practitioners, instead of a random sample or a convenience sample (those both considered as weaker data collection approaches). The respondents were individuals from various organizations. Therefore, it is difficult for individuals to answer on behalf of the whole organization. Further, respondents in diverse positions may have different opinions and familiarity about the organizational practices.

Thus, different views could affect the reliability of the results to some degree.

We purposely chose the “Lean Software Development” LinkedIn community as the population, to get an apt data sample. As they have an appropriate understanding and experience of using Kanban. LinkedIn groups and professionals are considered as good source of data collection from all seniority levels of researchers and practitioners [9]. However, the population of this type may cause positive biasness in the results. It is also possible that many of the respondents were the ones with high-level interest in Kanban and open to try new methods in general.

VIII. CONCLUSION

Kanban has many success stories in software engineering. It is a good tool for visualizing work within and between teams. It helps team members to avoid burdening multitasking by limiting to work in progress. Such actions indirectly enable continuous delivery to the customers. The goal of this study was to examine the antecedents of successful Kanban usage to achieve optimum benefits from it.

Our results exhibit that enabling antecedents (such as organizational support, experience, training, ease of use, and subjective norm), play a vital role in the context of software development innovations’ adoption as well as pertinent in realizing Kanban benefits. The findings of our study are aligned with earlier studies [8][11][20] which have identified the importance of these antecedents with respect to acceptance and usage of software development methods. The greater the organizational support the more benefits of Kanban use are achieved by the practitioners. This is also reflected in subjective norm and training, which have correlation with achieving optimum benefits of Kanban. It is beneficial for companies, when they find their influential individuals who have adopted Kanban and/or endorse its use.

This study highlights the importance of Kanban training; however, it is essential to allow Kanban experimentation in specific context(s). Once a team adopts Kanban to their work, they will achieve its benefits. The study shows that management experiences more benefits, therefore the assumption is that they have more freedom to adopt Kanban based on their circumstances, needs and nature of work. Practitioners need to monitor and evaluate realization of the antecedents which are reported in this study. Constant evaluation and observing will aid to sustain good Kanban use and achieve maximum benefits.

In the future, similar studies are required to investigate these antecedents in more detail. Further studies need to be carried out to replicate the study, on different teams and different organizations, to accept or refute the findings and to help in the generalizability.

REFERENCES

- [1]. M.O. Ahmad, D. Dennehy, K. Conboy, and M. Oivo, "Kanban in software engineering: A systematic mapping study". *Journal of Systems and Software*, 137, 96-113. 2018.
- [2]. L. Vijayarathay, and D. Turk, "Drivers of agile software development use: Dialectic interplay between benefits and hindrances". *J. Info. and Software Tech.* 54(2),137-148. 2012.
- [3]. VersionOne, *The 12th Annual State of Agile Survey Annual State of Agile Survey*. 2018.
- [4]. F. K. Y. Chan, and J.Y.L. Thong, "Acceptance of agile methodologies: a critical review and conceptual framework". *Decision Support Systems* 46, 803–814. 2009.
- [5]. M. Laanti, O. Salo, and P. Abrahamsson, "Agile methods rapidly replacing traditional methods at Nokia: a survey of opinions on agile transformation", *Information and Software Technology*. 53 (3), 276-290. 2011.
- [6]. A. Qumer, & B. Henderson-Sellers, "A framework to support the evaluation, adoption and improvement of agile methods in practice". *Journal of Systems and Software* 1899–1919. 2008.
- [7]. M. Pikkariainen, X. Wang, and K. Conboy, "Agile practices in use from an innovation assimilation perspective: a multiple case study". *International Conf. on Information Syst.* 2007.
- [8]. C. K. Riemenschneider, B. C. Hardgrave, & F.D. Davis, "Explaining software developer acceptance of methodologies: a comparison of five theoretical models". *IEEE Transactions on Software Engineering*. 28 (12), 1135-1145. 2002.
- [9]. M. O. Ahmad, J. Markkula, and M. Oivo, "Insights into the perceived benefits of Kanban in software companies: Practitioners' views". In *Agile Conference* 156-168.
- [10]. M. O. Ahmad, J. Markkula, M. Oivo, and P. Kuvaja, "Usage of Kanban in software companies: an empirical study on motivation, benefits and challenges". *International Conference on Software Engineering Advances*. 2015.
- [11].M. Senapathi, and A. Srinivasan, "Understanding post-adoptive agile usage: An exploratory cross-case analysis". *Journal of Systems and Software*, 85(6), 1255-1268. 2012.
- [12].T. Dybå, T. N.B. Moe, and E.M. Mikkelsen, "An empirical investigation on factors affecting software development acceptance and utilization of Electronic Process Guides". *International Symposium on Software Metrics*. 220–231.
- [13].T. Dybå, and T. Dingsøy, "Empirical studies of agile software development: a systematic review", *Information and Software Technology*, 50, pp. 833-859. 2004.
- [14].P. Runeson, & M. Höst, "Guidelines for conducting and reporting case study research in software engineering". *Empirical Softw. Eng.* 14(2), 131–164. 2009.
- [15].J. C. Nunnally, "Psychometric Theory". 2nd ed. New York, NY, USA: McGraw-Hill, 1978, pp. 229- 246. 1989.
- [16].J. Iivari, and M. Huisman, "The relationship between organizational culture & the deployment of systems development methodologies". *MIS Quarterly*, 35-58. 2007.
- [17].C.J.Kaemar, D.J.McManus, E. W. Duggan, J.E. Hale, & D.P. Hale, "Software development methodologies in organizations: field investigation of use, acceptance, and application". *J. Information Resources Management*, 22 (3), 16-39. 2009.
- [18].A. Bandura, "Self efficacy: The exercise of control". New York: Freeman. 1997.
- [19].F. Davis, "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology". *MIS Quarterly*, vol. 13, no. 3, pp. 318-339. 1989.
- [20].B.C. Hardgrave, and R.A. Johnson, "Toward an information systems development acceptance model: the case of object-oriented systems development". *IEEE Trans. Eng. Manage.* 50(3), 322–336. 2003.
- [21].J. Drobka, D. Noftz, and R. Raghu, "Piloting XP on four mission-critical projects". *IEEE Software*, 21 (6). 2004.
- [22].T.L. Roberts, & C.T.Hughes, "Obstacles to implementing a system development methodology". *J. Syst. Manage.* 47(2), 36–40. 1996.
- [23].L. Williams, L. Layman, and W. Krebs, "Extreme Programming Evaluation Framework for Object-Oriented Languages Version 1.4", *NCSU Technical Report*. 2004.
- [24].O. Salo, and P. Abrahamsson, "Agile methods in European embedded software development organisations: a survey on the actual use and usefulness of Extreme Programming and Scrum". *IET software*, 2(1), 58-64. 2008.