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Research paper

Issues of lean-agile software development environment

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Abstract

The popular waterfall model is widely accepted approach for project management paradigm; however lean based agile model is the recent revolution to reduce work in progress items and makes transformation to better process by identifying and eliminating non-value-add activities and increase productivity with quality of deliverables. This paper includes the issues that involved in lean- agile process.

Keywords: *Agile Methodologies; Kanban; Scrum, Lean; Value Stream Mapping (VSM); Waterfall Model.*

1. Introduction

In today's world, customer wants to work in an environment where they drive more control of the product development. They want to adopt a culture of introducing frequent changes and seek quick solution, which enables them to visualize and decide schedule to make product live. In other language, customer wants an incremental product enhancement despite of current volatility and uncertainty prevailing in market. Due to this, customer would like to accustom itself with new trends rather than stick itself to old model, where scope, schedule and timelines are fixed during initial phase of development and lots of approval processes are involved to move ahead from preceding phases. Currently customer's priority has changed from stringent timeline, scope and budget to more interactive and responsive agile model. The advantage of this model is to align development work in line with the changing business needs. This newly invented process came around 2001, where several process methodologists conducted meetings to discuss future trends in software development. They observed that the newly invented process model has a lot of similarity due to which they named this model as agile, means a combination of light and efficiency [2]. This model emphasizes on having more of people interaction, working software and customer collaboration [19], which will help achieve a better quality output. In old days, there was a process [10] model known as Kanban that widely used to achieve effective use of this agile model [16]. Kanban is a model where team's maximum focus is to eliminate the work-in-progress items by using Kanban board. This model not only minimizes WIP (Work-in-progress) items and but also increases information flow within project. Generally Kanban board is used for graphical representation of all the activities involved. One of the key concepts behind Kanban model is the entire process flow can be optimized by reducing the work-in-progress items. The other valuable aspect is to reduce the unused items; those can be easily achieved through Kanban process flow. The above model of removal of unused (non-value add) items is known as lean. In other way, lean is an agile model, whose objective is to create value and eliminate the waste for customer. Apart from waste elimination, there are certain defined principles of agile processes which widely used are known as agile manifesto. In addition to this, there are some literature reviews already available on challenges due to the adoptability of agile based lean model.

The next section, Section 2, provides a quick background on environment of agile development Section 3 explains the need of agile environment. Section 4 discusses the challenges and limitation of agile model. Section 5 explains the connectivity within agile lean Environment. Section 6 shares a brief literature review of agile process of software development. This is followed by Section 7 that represents the conclusion of the study.

2. Agile software environment

Agile is a software development environment [13] where development happened continuous and progressively. The primary focus areas of this model are team collaboration and respond to frequent customer change. In other way, it is known as an alternative approach to document driven, heavy weight process model. Apart from this there are certain values [11] and principles which always need to be prioritized are known as agile manifesto. Following are the core values of agile:

- It requires individual contribution and interaction rather than following strict process and tools to complete the project.
- It focuses more on workable software rather than following tedious document.
- It involves more on customer collaboration rather than contract negotiation.
- This model always ready to respond the frequent change request by customer rather than following stringent project plan.

Apart from the above principles & values, there are many agile related development methods, which are widely used in software development methods [22]. Those are DSDM (Dynamic System Development Methods), XP (Extreme programming), Crystal Clear, FDD (Feature driven development) and Scrum. Out of all these methods, Scrum is widely used [17]. Initially it was only used for software development [18] process model, but latter it formally accepted as it works well for any complex and innovative scope of work. Like waterfall model, scrum is also divided in to logical modules which known as sprint. Sprint is usually 2 to 4

weeks of duration, where it covered engineering works of design, analysis, development and testing. This sprint is defined and prioritized by product owner (Business person who own the product) with the help of project team and scrum master (Facilitator for the product) [14].Scrum master conduct 15 minutes of daily stand up meeting every day to for tracking and ensure completion of assigned tasks, next assignment and if there is any impediments to achieve this target. Product owner has to conduct retrospective meeting to understand best practices, key learning and plan and prioritize backlogs [14] items for next sprint. Pictorial representation of above scrum model is shown Figure 1 that includes product owner, team commitment, scrum master, daily meeting and potentially shipping product.

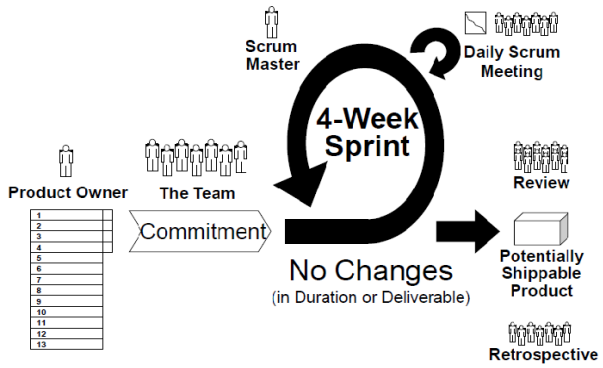

Fig. 1: Scrum Methodology of Agile Model.

Acceptance of scrum methodology is increased now a day, but not free from challenges during end to end implementation. In order to mitigate these challenges, lean with agile model is an important option, which is elaborated below:

2.1. Lean

Lean is suggested by Mary Poppendieck and Tom in their book to focus on maximization of value and elimination of un-used items or waste. This concept is immerged in the early years of the Japanese automotive industry. While there is no commonly agreed upon definition of lean [8], the five original principles of Lean thinking are:

- Value – The work or tasks, which create value or worth to customer. As per deliverable, those tasks should be as per customer expectation, within scheduled time, scope and estimated cost.
- Value stream mapping – The work that makes sure that the actions that bring a product from initial vision through Implementation and provides value to customer.
- Process Flow – The work ensure that the value stream does not have discontinuities so that activities are organized as a continuous 'flow' enabling smooth deliveries.
- Pull process model–These processes is useful when customer is needed (just-in-time basis). Customer would take interest to shift the mindset rather than push with different process model.
- Perfection in delivery–The high level of standard maintain in quality deliverables.

2.2. VSM (value stream mapping)

VSM is part of a lean process that helps to eliminate waste [3] or un- used items. It identifies the current state of process, value added and non-values services and maps the current and future state of process. Using this mapping tool action items can be listed down to achieve the target. For any organizations, there are three types of activities are undertaken, as shown in Figure 2 that include value-add activity, non-value-add activity and business non Value-add activity. Each of them discussed below:

- Value-add activity – add value to the Product/services and customers are willing to pay for it.
- Business non-value-add activity – wasteful but are necessary for running the organization and customers are unwilling to pay for sit.
- Non-value-add activity – involve unnecessary actions not adding any value to the product/services. Absolutely waste and customers are unwilling to pay for it.

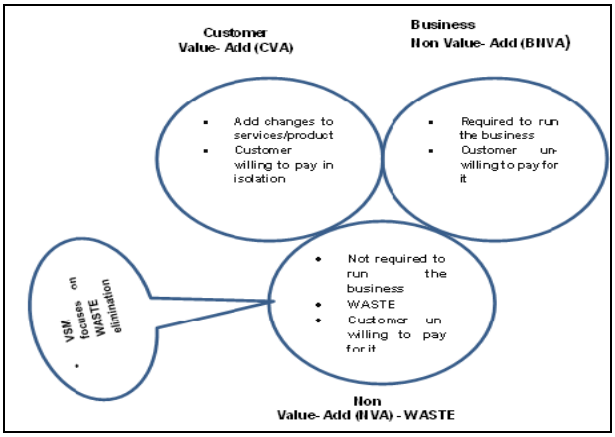

Fig. 2: Three Types of Activities In Lean.

2.3. The historical data's about agile software development

This section elaborate a gist of earlier usage of agile methodology, lean practices and principles This historical data's collected through various survey conducted through questionnaire's for different sections, e.g. size of the organization, current organization process model, ready to adopt agility, if not using currently, usage of different agile methods (If Organization current using), challenges of adopting agile if the organization is already using different process model. Following section give overview of some of the above key areas.

2.4. Non-adoption of agile methods - reason

In order to find the root cause for non-adoption of agility, survey is conducted with various possible questionnaires with different practitioners [4, 5], where agile or lean are not adopted yet. Analysis of this result will give an idea behind reason. The depth analysis and suggestion of these data's are represented in table 1.

Table 1: Gap Analysis for Non-Agility Based on Newly Market Trends

Sl. No.	Questionnaire - Find the reason for non-agility	%of Users
1.	Resources of the Organization are not adequately trained and knowledgeable.	46.7
2.	Don't like to change the parent culture of traditional process.	43.1
3.	Management doesn't like to be changed.	20.4
4.	It is difficult to change current fixed price contract.	18.2
5.	Lack of customer readiness or Un-willingness from Customers to adapt the new agile, lean methods.	16.1
6.	Not ready to adopt new trends.	13.1
7.	Difficult to adopt new trends in current tools and technology	12.4
8.	Business domain is not compatible to adopt/ It would be over head to change agile/lean methods.	8.8
9.	Quality adherence processes are not adequate to follow.	7.3
10.	Project requirements are non-consistence.	7.3
11.	Inadequate tracking mechanism to gauge the progress.	6.6
12	Un-availability of adequate skilled person to understand customer requirement.	6.6
13	Scalability is not properly defined.	5.1
14.	Newly adopted systems are not supported for reward or recognition.	4.4
15.	Un-availability of major design up front.	4.4
16.	There is hardly any support for re-usable facts building	4.4

17.	There is hardly any support to build newly distributed environments	2.2
18.	Predictability are decreasing gradually	1.5

The analysis of above table-1, shows the common reason for not adopting agile model is the un-availability of adequate trained and skilled resources and not ready to accept cultural changes. The next sub section represents the gap analysis of adopting agile and lean process model.

2.4. Adoption of agility and lean - reason

In current competitive market trends, companies are bound to improve their performance, revenue and margin. To achieve these factors adoptability of agile, lean are the most preferable approach. Initially, this approach was designed for individual and small scale industry. But, later it was tried for large scale organization. The subsequent section elaborate the issues, challenges and success factor, which has been considered for large scale under the umbrella of agile, lean development environment shown in table-2.

Table 2: Success Factors in Transformation of Agile Model [9]

Key Areas	Factors associated with
Organizational	• Ensure to maintain proper agile style work environment • Ensure to maintain collocation with entire team • Ensure to maintain Co-operative culture organization rather than hierarchal • Encourage for high value, face-to-face communication • Ensure organization is universally accepted agile methodology • Ensure proper Reward system is in place for agile • Ensure Quality is maintained for all deliverables
Key Success parameters	• Ensure to meet scope of the requirements • Ensure to deliver in given Time • Ensure to deliver the product within estimated cost • Ensure to maintain the right communication by following daily stand up meetings
Required Process to maintain	• Ensure to follow correct requirement management processes of agile • Ensure the scope of the project is well-defined • Ensure to use agile-friendly tracking mechanism • Ensure to follow agile-oriented configuration management process • Ensure to maintain a good and friendly customer relationship
People Required to maintain	• Ensure to maintain self-organized and motivated team • Ensure adaptive management style are maintain by managers • Ensure team to maintain the high skilled and competency
Standard Technologies	• Well-defined coding standard is imposed to use • Imposed to adopt simple design • Re-factor of code is imposed at every logical end • Bare minimum documentation are required to maintains • Ensure dynamic, accelerated project schedule is maintained
Cost, Schedule, resources for Project	• Ensure there is no share resource are working with project • Costing and staffing need to be completed upfront
Expectation of project performance	• It is useful to use agile software development projects • Ensure all the tasks are accomplish by using agile software development projects • Productivity should be increased by using agile model

3. Need of agile software environment

As mentioned above, now day's customer is not ready to wait till the end of the project tenure to visualize the product. In fact, customer or business is not well adverse with the complete project requirement at the initial phase. Hence, this methodology agile came in picture, where you can consider any change or requirement at any time. The key benefits of this methodology have been depicted in Figure-3.

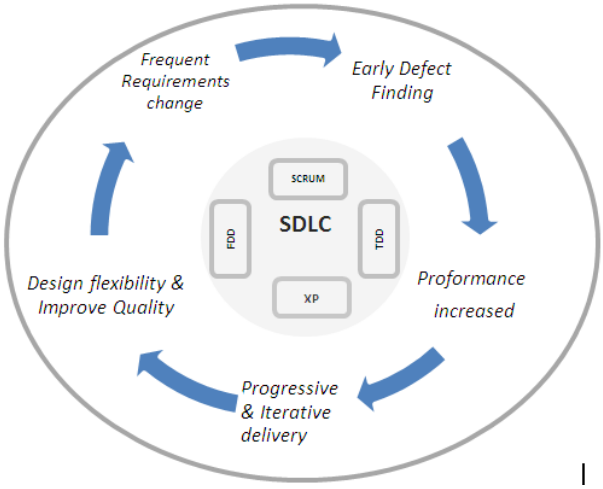

Fig. 3: Agile Software Development Methodologies with Benefits [6].

3.1. Capture customer change requirement

Capturing customer requirement at initial phase is important in any project life cycle. This will help to baseline the scope and reduce the risk of requirement uncertainty. Customer involvement at the initial stage helps for robust planning. Customer and all required stakeholder need to part of sprint planning, where all the requirement are estimate, prioritize, and plan for execution.

3.2. Early detection of fault

In agile, Testing is key element, tester has to involve starting of iteration to understand and design the test cases. Due to this early involvement of tester and rigorous testing defect count are very minimal. Tester could fix the defect before it pile up and increase the severity level. This continuous testing enabled to delivered robust and quality code.

3.3. Performance improvement due to frequent interaction

Due to frequent interaction through daily stand up meeting, flow of information are increased drastically. This helps the team to fine tune the requirements understand customer better and could delivered better quality output for end users. It also helps to create an opportunity to exchange relevant information, improved knowledge sharing and boosts the morale of the team members. This indirectly helps team to improve their productivity and delivered better performance.

3.4. Continuous integration and Incremental progress of delivery

The best part of this model is to divide the major delivery in smaller batches or functional modules, which could be delivered incrementally. This leads to better quality, risk management. Generally, it takes one to four weeks of duration to complete any iteration. These four weeks includes requirement analysis, planning, coding and testing. The beauty of this incremental delivery is end users have not to wait till end of milestone rather can monitor and check the product incrementally.

3.5. Robust and flexible design model

Quality deliverable depends upon robust and flexible design model, It is easy to change and maintain the code if the design is flexible enough. Any requirement changes latter stage could be easily accommodate due to flexible design model. This also helps developer for better code management

3.6. Quality Improvement

Recent report shows quality has increased due to adoption of agile methods. Methods like TDD (Test driven development), code refactoring enforce developer for higher reusability of code. Apart from this flexible design and architecture leads to improve code performance, which indirectly help to improves to quality. Frequent and friendly communication helps to close the blocker issue faster and increase turnaround time.

4. Challenges and limitation

There are still some challenges while adopting this newly trend agile model [6]. Here are some of the key challenges:

- Usually face difficulties for scaling agile in the large
- It is very difficult to change the organizational/people culture
- Find difficulties to get personnel with right skill and experience
- Apart from the above, there are some limitations in agile model, e.g.:
- The main focus is on development rather than design or end- user. The focus area is basically on processes for getting changed requirements, developing code, testing rather than focuses on product design
- Test coverage is limited whereas testing lead time is very high
- Agile principles are still not fully utilized, as the team expect higher involvement of manager efforts in co-ordination communication
- It is not fully successful for large project, as some of the iteration need to complete minimum functionality
- There is no restriction for time, as some of the feature may take longer period of time to execute
- It may increase the cost due to adoption agile model for large complex project
- Due to extensive communication and team work, it may increase management overhead

5. Connectivity agile lean environment

Although customer is ready to accept the newly market trends, there are some similar features already using in current model, which are highlighted below. Agile, Kanban and Lean are the latest methodology, where customer is very keen to adopt on this model. This methodology is not only help faster execution and but faster time to market. Team needs to align with user requirements, acceptance test scenarios, and extensive use of monitor the progress through burn down chart. Table-3 shows that the connectivity between three newly accepted development models [12].

Table 3: Comparison of Different Model Agile, Lean and Lean with VSM [7]

Steps for Agile process model	Steps for Lean process	Step for Lean with VSM model
1. End users requirements of functionality 2. Acceptable test case after completion for Business approval 3. Progressive development of features or functionalities 4. Monitor the consumption vs Effort left 5. Highlight and track end- user requirements in a board 6. Daily Status call to monitor the progress 7. Design of Test suit in parallel with development 8. Integrate the code with parent node continuously	1. End users requirements of functionality 2. Acceptable test case after completion for Business approval 3. Highlight and track end- user requirements in a board 4. Daily Status call to monitor the progress 5. Design of Test suit in parallel with development 6. Integrate the code with parent node continuously	1. End users requirements of functionality 2. Acceptable test case after completion for Business approval 3. Highlight and track end- user requirements in a board 4. Current State Map (Value-add activity, Non Value-add activity) 5. Future State Map 6. Design of Test suit in parallel with development 7. Integrate the code with parent node continuously

Ttable-3 also indicates the common features of each development model and suggested for further improvement on the performance.

6. Literature review

In this section, some expert views are recorded and shown their focus area, scope of work in Table-4.

Table 4: Summary of the Literature Review

Views	Focus Areas and Probably scope of work
Raju and Krishnegowda [1] focuses on different process areas where customer is currently aligned and would like to incline near future. The review also suggests a comprehensive study of lean and different existing Pull system and how it impacts the quality of the deliverables.	Focuses on different Quality process areas and approach to make them best fit as per customer requirement
Roy [7] focuses the Failure of information systems in traditional approaches and how it forced the system development to the current approaches (i.e. traditional)to Agile approach.	Focuses the Failure of Traditional System to Agile Model.
Tripp et al. [8] focuses on challenge on of current traditional model & advantage of using agile model	Focuses on open questions and challenges on usability agile & future trends.
Maria [10] focuses the success factor of lean, agile simulation model. This paper demonstrate different model of simulation and shared their challenges to achieve this goal.	Success story Agile & Lean implementation using simulation.
Eetu et al. [11] focus on benefits on using different metrics to gauge the productivity and quality deliverables. They also try to identify the values addition by using those metrics.	Focus on different type's agile matrices and their usability in software environment.
Hansen and Baggesen, [14] focus on CMMI and movement to Scrum, Agile, Lean and collaboration model where they can gauge the deliverable, Quality and productivity.	Focus on CMM process and benefit of shift to agile model.
Gurumurthy and Kodali [15] are focused on VSM over LM (Lean Manufacturing) and major reason of agile failure. As per their experience, managers and all relevant stakeholders need to understand and act upon the next step after successful agile transformation.	Focused on VSM over LM, which could be reason of adoption after shifting the Organization to Lean.
Polk [16] focuses on the process creation and	How Agile , Lean pro-

the improvement achieved on that process with the help of Agile/Lean system. He created a process frame work to improve the process & productivity, which helps to grow the business and improve in Cycle time as well as Lead time.	cess help to reduce Cycle & Lead time
Blau and Hildenbrand [17] focus the challenges faced large team in agile & related development methodologies. They have brainstorm and presented the resolution approach for identified issues.	Issue & challenges by using agile in large scale. They also proposed approach for resolution.
Kamat [19] focuses on successful factors of lean, agile in manufacturing and software field. Data's show that the best agile principles can be adopted in any industry to get productive and faster rate of result.	Lean and Agile practices in manufacturing and software industry.
Kaushik [20] focus on the need and additional features of agile development those can benefits in current market trend.	Features & benefits of Agile in current market trend
Owen et al. [21] focus on agile project management that helps to optimize customer experience and create enormous values. This new evolution can act as a differentiator for process and quality improvement any product or services.	Focus on key features of agile project management which may act as a differentiator.
Swaminathan and Jain [22] focus on concept of continuous improvement and eliminate the waste in Agile Project. The focus are of Lean Idea is to identify the non-value-added services & improve the productivity, throughput by continuous learning (from mistake) & improvement. The case studies specify that Agile and Lean concepts are correlated.	Identify the non-value-added services & improve the productivity by continuous learning.

7. Discussion

Based on the literature review, it is found that Agile is the latest business model for current competitive methods [20, 21], where customer expectation can be captured and prioritize at work. It also helps to capture frequent changes from customer and modularize them based on customer need for better quality deliverables & market it in-time.

As of now there are number of papers that highlighted the issues close to the background and purpose of this paper that need to be raised, starting out with Gurumurthy and Kodali [15], who stated that management has limited knowledge of understanding and "how an organization will be" after it gets transformed. This continues with Owen et al. [21], who mention the need to create a better way to map the customers' needs to attributes of both the requirement and services simultaneously. Lastly Polk [16], who also focuses on the process creation and the improvement, achieved on that process with the help of agile, lean based system understanding of requirements.

Table 5: Summary of Applications of Lean

Lean Wastes/DevOps Practices	Continuous Planning	Continuous Feedback	Continuous & regular delivery	Continuous Integration	Regular Testing	Continuous & regular monitoring
Waiting Period	✓	✓				
Addition of Extra Features	✓	✓	✓		✓	✓
Additional Processing time	✓					
Movement	✓	✓		✓		
Unable to complete entire work	✓		✓			
Shifting of tasks based on need basis	✓	✓				
Fault detection	✓				✓	✓

The authors mentioned above [11], [19], [20], [21], [23] were investigated further after the main review to see if their subsequent research [8] had looked into their highlighted issues. It is cleared from these literatures review that future mapping model can connect agile with lean (VSM), which will reduce the development efforts. The next section gives comparative studies of each process used in agile and lean methodologies as per the observation in literature review. This has been summarized in table-5 by considering several emerging areas of lean and it provides a short description of the opportunity, challenge, and then discusses the criteria may be used [5].

In current lean process model, there are many waste or un-wanted tasks come into pictures e.g. waiting period (wait for approval to move for next process or cycle). This waiting period has no value to customer. Moreover this is a waste, which has no or least important from customer perspective. Similarly extra features, is a nice to have for customer, but it is not mandatory to deliver as this is not part of contract. Similarly, extra processing time or fine-tune the product is not a customer expectation, but nice to have feature. Partial work done is another waste where customer requirement is not met, as customer would expect complete product rather than partial of incomplete product. Shifting of tasks is another form of waste where critical tasks are re-assigned based on efficient team members. Fault detection or defect is waste, where rework efforts is involved and team needs extra efforts to fix it, which does not create any value, The objective of this comparative study is to identify the lean practices, those create values e.g. continuous planning, feedback, delivery and continuous Integration of product, continuous testing and continuous monitoring.

8. Conclusion

The paper concluded with followings:

- Flow based pull system known as Kanban offers an opportunity to reduce work in progress items and makes transformation to better process with the help of lean Value Stream Mapping (VSM). Lean VSM helps to bring in significant improvement on deliverables.
- It inference that in order to sustain in current competitive environment customer has to come out of traditional waterfall model and need to adopt alternate approach to develop and deploy product, services at faster rate. Lean based agile is the prefer way to prioritize tasks with value added services, which reduce cycle time and ensure faster time to market the product.

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