A THEORETICAL MODEL TO ANALYZE LEAN PROCESS MODEL FOR TIME-BOUND PROJECTS

Afshan Alam[1], Uzma Jamil[1], Shahzad Hassan[2], Muhammad Zeeshan Asaf[3]
[1]Department of Computer Science, Government College University, Faisalabad, Pakistan
[2]Department of Computer Engineering, Bahria University, Islamabad, Pakistan
[3]Department of Computer Science, University of Agriculture, Faisalabad, Pakistan
[1]afshanalam24@gmail.com, [1]uzma.jamil@gcuf.edu.pk , [2]shassan.buic@bahria.edu.pk, [3]zeeshan.asaf@uaf.edu.pk

ABSTRACT— *The Term "project" is known as an undertaking that has a start as well as an ending; it is conducted to accomplish recognized objectives contained by cost, time limits and quality goals. So, it can be established that a project has limited time frame which means projects has time constraints and a project must be completed & delivered to client within that specified time thereon. If the project is delivered after that time frame deadline, the project will lose its value to a large extent. Lean software development" (LSD) can be utilized for on time delivery of time bound projects by focusing on the key areas such as education &training can lead toward waste eradication which smoothen the roots for Continuous and Sustainable upgrading along with assurance of outcome. In This research work it will be focuses on why some of the software development projects got failure in spite of inserting human & financial & technical resources by examination of source causes for the reason. By declining waste and improving customer satisfaction, the Lean process saves companies financial recourses and improves overall success. And applying the principles of Lean process for such projects and pick up the project for enhanced outcome for time-related projects.*

Keywords—: Lean Software Development, Principles of Lean Development, Waste Elimination, Project Failure

1. INTRODUCTION

The term "Lean" means an effort to derive more value for clients with fewer amounts of resources available. Then initiative is to maximize customer value whereas minimizing wastage of time & other resources [1]. Lean is a widespread production standard that is being adopted by the organizations globally for the purpose of enhanced profit, lessen expenses and improved their economic positions [2]. The main goal of the Lean was to identify and eliminate waste related to the time, struggle and the substance throughout the project lifecycle. In this way, Lean assists the organizations to achieve that goal and maximize productivity. Mainly the lean was industrialized to reduce wastes in manufacturing, however, the ideology of Lean is being applied in the other industries too [3]. As value chain is identified & it is specific to an organization, so value adding activities are recognized, wasted steps are removed, and flow of communication from client to project teams and requirements pulled form to end users are taken in developing Lean software, embark on the process again and follow on continuous improvement strategy until a state of excellence is reached in which ideal value is created with no squandering.

The term lean was coined by Toyota in 1990. By its production system in Tokyo. Bu using Lean principles Toyota had been the first car manufacturer in Japan and then changed over all the World [4]. A project that has restricted time constraints i.e., the project must be delivered on a scheduled time frame otherwise it losses much of its worth [5]. It seems that Cutting content is a long way to reach the deadline in projects with a delayed duration. But why would you want to work on this thing and waste valuable time & efforts, which are most likely, an initial symbol of problems? Why do not you make decisions about important things and you just start working if you have the necessary time? There are many activities occupied in the manufacturing of goods or appliances. Most of these activities often increase the value of the end product to the customer's perspective. Usually, customers only have to pay for activities that add value to goods or appliances. The activities are of two types:

Value added Activities: add value to customer's perspective. **Non Value Added Activities:** The type of activities that do not add much value to the product. Traditionally, the manufacturing industry has the greatest impact on the use of machines and labor so believes in make the best usage of the machinery and manpower. This approach develops products regardless of claim & requirements of customers, and the approach is known as "Make to Stock". It is initiated on Henry Ford's "Push Scheduling system" that produce the quantity where in manufacturing is carried out notwithstanding of the genuine requirements of the downstream process. As a result, either the inventory finished or not, if not get sold out, burdened the revenue of the industry. The Lean followers found MTS the major disadvantage in the production system. MTS leads to carrying up of undesirable heights of the catalogue. For the prevention of this system, Lean put emphasize on manufacturing only to the customer's requirement, and this ideology is known as "Make to Order (MTO)" [6]. It is founded on Toyota's "pull scheduling system" that leads to crop only required as much quantity and at that exact period and followed by the downstream process. Lean proposes numerous practices to let an organization gain profit and reduce the wastes. They are as follows [7]:

- just in time (JIT),
- kabana systems,
- single minute exchange of dies (SMED),
- cellular manufacturing,
- 5S systems
- Kaizen
- line balancing
- Standardized work procedures.

If an industry implements the above said techniques it can reduce the cycle of the product, inventory, cot, and flaws and enhance efficiency.

2. LEAN PROCESS

The Lean procedure is a method for creating a more efficient business by eliminating inefficient practices and improving competence [17]. More broadly referred to as "Lean," the Lean procedure focus on civilizing products and services based on what customer's desire and cost. By falling waste, improving customer satisfaction, the Lean process saves company's money and improves overall success.

Gaining a Lean capability is not impressive that can be done suddenly. Lean is an important job that requires full preparation and total obligation from the human resources. Lean manufacturing methods can help businesses get started Using a simple developed system Using a continuous perfection program Using metrics to gauge the competence of enhancement [18].

A. Fundamental Lean Principles for Development

Four fundamental Lean principles are considered much appropriate to software development are listed below *[19]*

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Fig 1 Principles of Lean Development

I. Identify Waste

In Lean thinking the initial step is to recognize the value and categorized the quite important resources to produce that value. The situation of shaping what is the value and what adds to that value is incredible that should be done at a literally high intensity. Identifying waste is the basic rather first step to build up breakthrough with Lean. Everything done without this way will be a waste. Taiichi Ohno acknowledged the seven wastes in manufacturing.

Fig 2 Waste of Lean Manufacturing

The above wastes of manufacturing would be translated into wastes of software development.

Table 1 Waste of Manufacturing into waste of Development

Waste of Manufecturing	The Waste of Software Development
Over production	Extra Feature
Inventory	Requirements
Extra Processing steps	Extra steps
Motion	finding Information
Defects	Defects not Caught byTest
Waiting	waiting
Transportation	Handoffs

II. Flow Value From Demand

The flow is the fundamental idea of Lean development. If you are just adding value instead of doing anything, then the value should be added as rapidly as possible. Else the waste grows in any of the form record, conveyance, additional phases or squandered motion. The scheme of flow 'pulled' from claim is crucial to Lean invention. 'Pull' way that zilch is completed till a proceeding method demanded it. The results by above method is not estimated centered; dedication is belated till the client requirement exists that points what the client need.

In Lean thinking, the ideology is to maximize the use of the flow of data and conveyed significance [20]. This doesn't stand for automation in its place; it indicates restraining what has to be conveyed, and conveying that a small number of times above the straight space with the largest bandwidth as belatedly as feasible. In Lean Development, the goal is to eradicate lots of credentials and hand overs as probable. Those leaflets which are not helpful for the clients must be changed with computerized tests. These tests guarantee that client requirement is at the start conveyed together in the latent when the expected changes are needed. In count to quick, Just-in-Time information stream, Lean Software Development indicates quick conveyance of value. In industrialized, the base to accomplish fast conveyance is to manufacture in minute groups pulled by a client order. As well as in software development, the fact to quick conveyance is to split the dilemma into minute groups (increments) pulled by a client account and test? The on its own mainly efficient method to implement Lean construction is to adopt Just-in-Time, pull-from-demand flow. As well as, on its own mainly efficient method to implement Lean Development is conveying batches of genuine trade value in small time-boxes. The accent is to couple a trained development team with a trained client team and a lot them the accountability and power to develop the system in short, fast batches, obsessed by client precedence and response.

III. Value added People

Every organization claims that its labor is important for the organization, but if they centralized the value added people, they could say that the people are the center of:

- Resources
- Information
- Process design Authority
- Decision Making
- Organizations Energy

It means improving the ability of developers all the way through guidance and training periods is all about "centralizing the value added people". That is creating squad that propose their personal procedures and deal properly with the problems. That is the staff teams and managers be present to prop up developers, rather than let them know what to perform.

IV. Optimize

Mostly, the major obstacle to adopting Lean principles is executive. As products travel from department to department, a large hole often produced, particularly id departments have different performance measurements from each other.

To overcome these obstacles Lean organizations are typically prearranged around teams that retain accountability for general business worth, instead of midway dimensions such as their capacity to contemplate and padding estimate. Another method is to promote a dedicated consciousness that the downstream section is a client, and gratifying this internal client is the vital performance height. The pattern alter that is necessary with Lean thinking is frequently mired if the organization is not prearranged around the stream of worth and paying attention on serving the client pull value from the venture. Owing to this reason, software development teams are greatest prepared around conveying batches of business worth, with the entire and essential skills on the identical team.

3. LEAN PRACTICES OF PRODUCT DEVELOPMENT

Dal Forno, et al. offered a collection of Lean practices for product development as follows:

B. Value Stream Mapping: To cultivate an image to see the non-value added things in the current state of the product and measure the preparation time *[21]*Then, in the ultimate state plot and perform the idea, developments are deliberated.

C. Visual management: visibility, either in the form of electronic or physical, in consideration of standardization, orderly to smooth a shared understanding of the team, it enhancement the problem visibility and clear the scope of project with quality, time and cost triangle. Also the visual management helps in tracking the meeting deadlines and prevention in time waste.

D. Set Based Concurrent Engineering: On SBCE, through the phases of product development process some sets of autonomous and corresponding substitutions are cultivated and forms by the whole development team and at the end the finest substitute is produced and verified in order to do it right the first time *[22]*. Hence throughout the development cycle the information must be in cadenced, constant manner and confirming the concrete claim of the proceeding phase. Also, the material should be accessible at the accurate time, place and quantity and vital to put on the Set Based Concurrent Engineering. According to *[23]*, the SBCE concurrently provides numerous likely elucidations for the project, segmented for multiple subsystems and progressively eliminates the weaker points until it meets the final solution, delaying to take the decision as late as possible till the maturity level of the project will permits to take it with the least probable jeopardy. Hence, the ultimate solution is considered that is more likely to actually be the best for the project.

4. RESEARCH METHODOLOGY

The main goal of this research is to portray a structure to break down Lean Process Model for Time-bound activities.

The core objective of this research is to reduce waste to make it practicable for development groups to spend additional liveliness while doing cost-effective work, a revolution that reduces phases and enlarges the degree of code that can be carried on deadline. This research will provide arrangements with continuous transportation while reducing development cycle time's percentage up to 50 percent. The policy in this hypothesis is correspondingly categorized effect of execution of Lean for Time-bound tasks. This theory is similarly suggested the approaches for coordination of these aerobics by using diverse improvement system while contrasting Lean Process Model and different process models. To achieve the desired goal of the research, an organized survey was established and used for employment of the survey in order to assess quantitatively and methodically answers and let superior elasticity for the assessment of outcomes.

5. ROLE OF LEAN THINKING TO PREVENT COMMON PROJECT PITFALLS:

Lean principles and the recognition of waste can help project managers avoid, lessen or control situations that might

otherwise lead to project failure [24]. Here's a list of common project pitfalls that Lean thinking can help avoid. Software Project managers can lessen or direct or stay away from the posture that go ahead towards fatal project by using Lean policies and core principle of identifying waste of Lean thinking. Some ordinal fatal project mistakes are listed below that can be prevented by Lean thinking [25].

a. ***Failure in ascertain consumer worth:*** Lack of customer value in can lead to waste effort, resources and price of the project. When a project manager realize the value his responsibility offers consumers, you can supplementary without a doubt set up project necessities, cost the project agreeably a customer wants to pay, and modify effort stream to accomplish the targeted project price.

b. ***Scope Creep:*** Scope creep take place while the significance of a project is augmented according the consumer demand, although, resultant budget and cost Variations don't excuse for that worth. This problem can be avoided by considering and reconsidering assessment to the Customer while span variations crop up, and guaranteeing that the augmented value is accompanied by a variation price

c. ***Failing to Define the Value Stream:*** Value stream mapping is an outstanding approach for differentiate the value added and non-value added actions in the project. Conditionally, value stream couldn't be defined with a judgment to surpass intended rate. In authenticity, the majority projects go through due to price and to-do list overruns, hence having the stakeholder's occupied support is very important.

d. ***Lack of Stakeholder Commitment:*** In an ideal sphere, projects the project must be completed on time and never surpass intended rate. In authenticity, the majority projects go through due to price and to-do list overruns, hence having the stakeholder's occupied support is very important. An investor who is not fully devoted to the project may be not as much probable to expand provision as soon as a project.

6. RESULTS AND ANALYSES

a. *Descriptive analysis of surveyed Software Houses*

In this section the results of 100 software houses are presented. According to the age of employees of software house the figure 3 shows the distribution of age group of the surveyed software house. The figure 4 shows the qualification of the employee interviewed to get the answer about the implementation. Figure 5 shows the percentage of male and female that are answered the questions about project completion and waste in project development process.

In table 3, the information according to the frequency and standard deviation allotted to the research questions on Lean Development is presented. Questions 6, 7, 8, 9,10and 11, with means of 21.8, 22.8, 18.6, 20.2 and 20.2, correspondingly, regarding the application of lean tools for value stream mapping and SBCE have lesser intensity average of application in the software houses were. Though, questions 1, 2,3,4,5 and 12 associated with lean principles have averages above 23.4.

The question 3 with the highest mean 25 and standard deviation (0.665) regarding the results of Lean Principles for Product development, showed the high potential of project completion on time. The question 8, concerning on a component of SBCE implement, showed the lowest average (18.6) with a standard deviation of (0.70) indicating a lower intensity of success of projects. Questions 4 and 5, on the subject of the use of SBCE, an elementary and precise tool of LD showed respectively 78.7% and 85.1% of the frequency of answers in the substitute to "disagree" or "agree" signifying the least use of this tool, having means of 23.4 and 24.47 about the application of value stream mapping tool, represented by questions 1and 2 are relatively a little greater, with average correspondingly of 24.45, 24.47 and with the frequency of answers of 63.8%, 72.4% and 74.5% in the substitute of "agree" or "strongly agree".

That was obvious, because this lean tool is reflected supplementary universal and prevalent. While, in the contrast improvement activities in the waste sockets specified by mapping (question 2) and the value stream map after improvements (question 3) are less executed, showing not full use of this tool. Thus, it is observed that the surveyed software houses are using lean principles to the PDP.

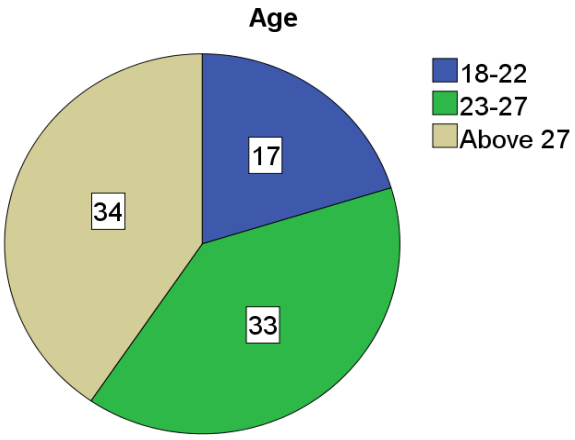
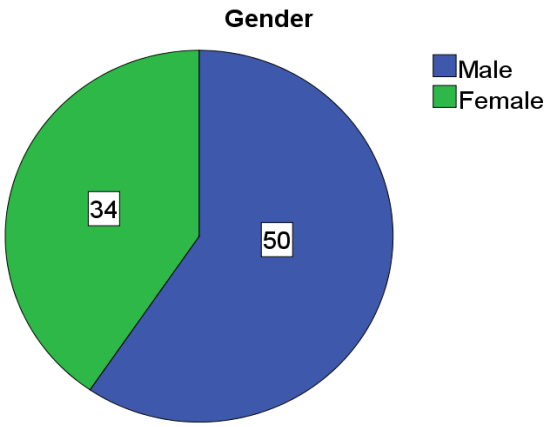


Fig 3 Distribution of employees according to age in software house.

Table 2 Lean Development in Respondent's Plant

Question	Strongly Agree	Agree	Disagree	Strongly Disagree	Average	Std.Dev
1. Does value stream mapping (VSM) applied in the project development process?	17.0	10.6	53.2	17.0	24.45	0.622
2. Where the waste sockets recognized in the value stream mapping of the PDP, the improvement tools applied there?	19.1	44.7	27.7	6.4	24.475	0.631
3. Is the value stream mapping completed after the use of improvement tools in waste sockets recognized at first?	19.1	44.7	29.8	6.4	25	0.665
4. Does all the alternatives begin to develop for project solution identified early in the project? Does it eliminate that solutions which present failures till it touches the absolute solution?	2.1	76.6	12.8	2.1	23.4	0.617
5. Does a chief engineer/ leader nominated for each project of a new project with great procedural and supervisory skills and with at least 5 years of understanding in the project zone?	29.8	55.3	4.3	8.5	24.475	0.673
6. Does the technical Capabilities of each project development engineer developed, esteeming the progress and deepening proficiency in their areas?	2.1	4.3	25.5	55.3	21.8	0.798
7. Are the key target deadlines, acute points and growth of the projects are existing in a clear and graphical way for all areas involved in the project?	0.0	6.4	44.7	40.4	22.875	0.73
8. Are the available data in a clear way for the project team, defined in the previous question, continuously updated?	14.9	0.0	12.8	46.8	18.625	0.709
9. Is the senior management of the project involved in all phases of the project development process?	17.0	2.1	25.5	36.2	20.2	0.736
10. Are the people who acquire specific technical knowledge to develop a project allocated to the development of new projects that use the same knowledge?	2.1	10.6	6.4	61.7	20.2	0.768
11. Does project development team know the causes of the constraints/flow problems?	2.1	4.3	25.5	44.7	19.15	0.637
12. What collapse on the time bound projects and clients are these constraints/flow problems causes?	0.0	0.0	10.6	83.0	23.4	0.826

Fig 4 Distribution of gender in PDP



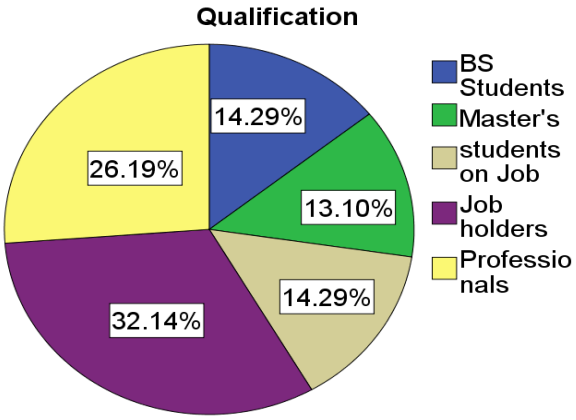


Fig 5 Qualification of employees

7. CONCLUSION

Growing ultimatum in finding for suitable projects administration methods in order to maintain and sustenance of applications has turn out to be a major job at the present time. Meanwhile Lean notions have emerged, experts from different trades as well as development have been reviewing and looking for the ways to implement this idea to their industries. A number of development companies have comprised the Lean culture

and have been using Lean principles and tools in their project delivery. The main goal of this study was to regulate the impact of Lean values on timely accomplishment of development projects. After analyzing survey results, we concluded that managing development projects by implementing Lean principles assists developers to deliver projects in advance of schedule. A few developers also stated that Lean policies even now in place aided their group to catch up and finish on time after suffering interruptions. In addition, we found that more or less all project managers of Lean projects characterized their experience with Lean as constructive, with efficaciously implementation of Lean principles as recommended by current theory. This study is relevant since it adds consistency to existing research that Lean principles can provide added value to the owner, and its applicability in development is valuable to developers. Many professionals are still doubting about Lean thinking and Lean tools, but consequences indicate that Lean projects are more likely to finish in advance of schedule than non-Lean projects, helping developers to be more effectual and lucrative.

We recommend reserves in further studies using meaningfully large sample sizes. Data on project accomplishment of Lean and non-Lean projects should be collected and matched for different states and countries. Ever since results point toward that optimistic experience can be attained, we also recommend that development companies ponder implementation of Lean principles based on current recognized guidelines for Lean implementation. Further studies on owner and team satisfaction are also encouraged.

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