A case study of Lean IT: Leading a Lean project in software development projects

Dorsaf Daldoul[1], Sahar Beji[2]

[1]University of Tunis El Manar, National Engineering School of Tunis, OASIS Laboratory, 1002 Tunis, Tunisia; [2] National Engineering School of Bizerte, Menzel Abderrahman 7035 Bizerte, Tunisia.
Email: dorsaf.daldoul@enit.utm.tn

ABSTRACT

Due to intense competition in the IT industry, service companies have been compelled to enhance the performance, durability, and stability of their operating systems. This paper focuses on two primary areas of investigation. The first area aims to identify the problem and deepen knowledge in the field of software development and Lean IT. This provides a foundation for observing and evaluating the performance of the case study company concerning the implementation of the Lean IT approach. The second area focuses on developing and implementing a waste identification and elimination tool, enabling the integration of Lean IT principles into the company's operational processes. This project represents the company's initial steps towards adopting the Lean approach.

Keywords : Lean IT; Software development; Lean principles; Continuous improvement

IEEESEM

1 INTRODUCTION

In the dynamic realm of technology and the highly competitive IT industry, service companies are compelled to enhance the performance of their operating systems to ensure their longevity, stability, and ability to meet customer demands in terms of cost, quality, and lead time.

To accomplish this objective, it is crucial not only to eliminate all forms of waste but also to embrace a continuous improvement process. This led to the emergence of the Lean IT approach, which builds upon the remarkable success of Lean Manufacturing principles and has brought about substantial transformations in the industrial sector [1][2][3].

Lean IT has been the subject of numerous studies and research papers, offering a comprehensive literature review on the topic. These studies aim to explore the application of Lean principles in the IT industry and its impact on organizational performance and efficiency. In this context, [1] examines the use of lean thinking in software development. The review found that there is limited research on the use of lean thinking in software development, but the studies that were found suggest that lean thinking can be effective in improving software development processes and outcomes. [4] examine patterns of successful agile software development organizations, including those using lean software development. The authors identify several key patterns, including continuous integration, collective code ownership, and frequent releases.

One of the fundamental principles of Lean software development is the elimination of waste. The study [5] argue that there are seven types of waste in software development: defects, overproduction, waiting, non-utilized talent, transportation, inventory, and extra processing. The authors suggest that by identifying and eliminating these forms of waste, software development teams can become more efficient and productive.
[6] expand on the seven types of waste and offer additional insights into how to apply Lean principles to software development. They suggest that teams should focus on creating value for customers, reducing lead time, optimizing the whole system, building quality in, creating knowledge, and deferring commitment. The authors argue that by adopting these principles, software development teams can create a culture of continuous improvement that leads to better software.

Overall, the literature review provides a comprehensive understanding of Lean IT, its principles, applications, benefits, challenges, and future directions. It serves as a valuable resource for researchers, practitioners, and organizations seeking to implement Lean principles in the IT domain. It is with this in mind that the case study company aims to explore and implement Lean IT principles in the field of computer systems. This endeavor presents a challenge that the company intends to overcome by drawing inspiration from the tools and achievements of the industrial sector. The primary goal is to integrate Lean principles into the company's operations and identify and utilize appropriate tools to enhance the software development process. This includes evaluating performance, and implementing necessary improvements for effective visualization and monitoring.

Copyright © 2023 IEEE-SEM Publications

The remainder of this paper is organized as follows. Section 2 presents the background of lean IT: Origins, principles and Tools applicable in Lean IT. Section 3 presents the Lean IT implementation approach. Section 4 provides evaluation of performance of the current company's process. The proposed solution is described in section 5, and her performance is evaluated in section 6. Finally, section 7 concludes the paper.

2 BACKGROUND OF LEAN IT

2.1 Origins of lean IT

The origins of Lean IT can be traced back to the application of Lean principles in the field of information technology. Lean IT emerged as an extension of Lean Manufacturing, which originated in the Toyota Production System in the 1950s. The principles and practices of Lean Manufacturing, aimed at eliminating waste and improving efficiency, were adapted and applied to IT processes and operations.

The adoption of Lean principles in IT gained prominence in the late 1990s and early 2000s as organizations sought to improve the efficiency and effectiveness of their IT functions. Lean IT focuses on identifying and eliminating waste, improving process flow, enhancing customer value, and promoting continuous improvement in IT operations.

Lean IT draws inspiration from various sources, including Lean Manufacturing, Agile software development methodologies, and other process improvement frameworks. It combines the principles of Lean Manufacturing with the specific challenges and characteristics of IT environments to optimize IT processes, reduce costs, enhance quality, and deliver value to customers. Over time, Lean IT has evolved as a distinct discipline, with its own set of principles, tools, and practices tailored for the unique requirements of IT organizations. It continues to evolve and adapt as technology and IT processes evolve, with the aim of continuously improving IT operations and delivering greater value to stakeholders [6]–[9].

2.2 Principles of lean IT

Lean principles in software development can be summarized in seven principles that closely align with the principles of Lean Manufacturing. The adapted principles applied in Lean Software Development are as follows (*Kupiainen , E ., Mäntylä M . V ., Itkonen J ., " Using Metrics in Agile and Lean Software Development - Using Metrics in Agile and Lean Software Development – A Systematic Literature Review of Industrial Studies*, 2015):

- Eliminate waste
- Decide as Late as Possible
- Intrinsic Quality
- Amplify Learning
- Delivering Quickly
- Empower the Team
- Optimize the Entire Value Chain

IEEESEM

The sources of waste that need to be eliminated in software development can be classified into nine categories, as presented in Table 1.

TABLE 1. LEAN IT WASTE

Waste	***Description***
Too many features (unnecessary)	It manifests itself in the development of unnecessary additional features and unnecessary documents. It is the worst form of waste, leading to cost increases and technical complications in the developed system: additional tests, maintenance, etc.
Delay	It results in delays in the development and delivery of work products and products. In an IT development company, the delay is due, for example, to expectations due to the availability of the people and the information sought.
Transfer	In IT development, the transfer mainly concerns the round trips of e-mails, the exchange of documents between the members of a team resulting in a considerable loss of information and knowledge. The transfer of information and skills for a new employee is also a kind of waste.
Reworking and reprogramming	Reworking and reprogramming in a development process are the stopping and restarting of the same work, redundant activities, and lack of standardization. They hinder planning and lead to delays and a drop in team productivity.
Partially performed work	Partially performed work may be unanalyzed and undesigned requirements, uncoded designs, untested or unintegrated code, undeployed features, or deployed features that do not minimize effort.
Travel, change of tasks	The multiplication of meetings, excessive procedures, physical travel, the performance of various simultaneous activities, constitute another form of waste.

Copyright © 2023 IEEE-SEM Publications

Waste	*Description*
	Indeed, taking charge of various activities prevents the actors concerned from carrying out their work quickly.
Defect	This type of waste concerns undetected defects in the codes, thus delaying the delivery of the IT solution and increasing the development costs.
Missed opportunity	It is manifested by an underutilization of skills, that is, not taking advantage of the ideas and potential skills of employees through a lack of listening and involvement.
Unnecessary management activities	It is the management activities that generate wasted time and additional management costs that do not produce value.

2.3 Tools applicable in Lean IT

To assess the suitability of Lean Manufacturing tools in the software development field, we have created Table 2, which outlines the tools, their objectives, their relevance in the IT domain, and justifications for their application. The tools utilized in software development draw inspiration from Lean production techniques.

IEEESEM

Copyright © 2023 IEEE-SEM Publications

TABLE 2. APPLICABILITY OF LEAN TOOLS IN THE IT FIELD

Technical group	Tools/techniques	Goals	Usable or not	Explanation
Problems solving	ISHIKAWA	Classify by family the causes likely to be at the origin of a problem in order to seek the relevant solutions	Usable	They are problem identification and resolution tools that can be used independently of the type of process
	5 Whys	Analysis of problems and identification of root causes	Usable	
	5W2H	Identify the problem	Usable	
	Pareto	List problems hierarchically	Usable	
	8D	Correct the effects of a problem and treat its causes to ensure that it does not reappear	Usable	
	7 Steps		Usable	
	QRQC	Manage non-conformities	Usable	
	GEMBA	Go to the field, the place where real actions occur in order to foster an in-depth understanding of real-world problems, observe directly and interact with collaborators	Can be used	GEMBA is a practice used in industries, but perhaps it can be converted into the software field. Indeed, in this field, the offices of the employees are the production field, so going to the field and discussing the problem with the team can be a kind of GEMBA

IEEESEM

Copyright © 2023 IEEE-SEM Publications

Technical group	Tools/techniques	Goals	Usable or not	Explanation
Risk analysis	FMECA	Analyze the risks: prioritize the risks according to their severity, their occurrence and their probability of detection	Usable	It is a risk analysis tool independent of the type of company (industry, design office, etc.)
Just-in-time practices	Heijunka	Production smoothing	Can be used	The goal of this technique is to produce the same quantity every day, but in the software field we do not talk about the quantity produced every day but we talk about the percentage of completion of the project. Perhaps we can convert the notion of quantity produced per day into percentage completed per day
	Kanban	It is a pull system that aims to eliminate overproduction and stock, i.e. work partially done	Usable	This technique is already applied in the software field. Indeed, it is summarized in a table called a Kanban table containing five columns: description of tasks, work to be done, work in progress, work to test and work finished
	Rhythmic production (Takt time)	Produce at the client's pace in order to deliver it on time	Usable	We can act on the factor of time in any field
	Lead time reduction	Reduction of production time	Usable	
Resource reduction	Small batch production: Break down the work into multiple deliverables	Facilitate tasks and follow the process in each step	Usable	This tool can be converted into the software domain by breaking down the work into several deliverables, this is a technique already used
	SMED	Reduce tool changeover time	Not Usable	This tool concerns the change of tools, but in the software field we have no tangible material

IEEESEM

Copyright © 2023 IEEE-SEM Publications

Technical group	Tools/techniques	Goals	Usable or not	Explanation
Human resources management	Team organization	Facilitate tasks and deepen information sharing	Usable	These are human resources management practices that do not depend on the type of company
	Cross-training	Strengthen everyone's knowledge and know-how and enrich skills	Usable	
	Staff involvement	Empower the team, develop creativity and contribute to continuous improvement	Usable	
Improvement strategy	Quality circles	This technique improves quality, improves employee knowledge and collects data	Usable	Improving the quality of the product or the way in which products (deliverables) are prepared is a practice used in software development companies
	Kaizen	Continuous improvement: continuously eliminate waste	Usable	Continuous improvement is a state of mind that applies in different ways depending on the field of activity
	A3 report	Project management tool: allows a good visibility of the problems/opportunities and the progress of the resolution of these as a team	Usable	It is a synthetic and structured tool for analysis, presentation, restitution of the resolution of a problem or the progress of a project. It is independent of the type of project
	Daily round table	Update work and resolve issues as they arise	Usable	The software domain process is already based on this principle: daily meetings
	Dashboard	Management and decision-making in order to achieve performance objectives	Usable	It is a practice more applied in the computer field than in the industrial field
Control of defects	Poka-Yoké	Système anti-erreur qui vise à empêcher l'erreur	Usable	Ce sont des pratiques utilisables dans les industries et peuvent être convertis dans le domaine software. C'est le même principe, la seule différence est la manière d'implémenter la solution.

IEEESEM

Copyright © 2023 IEEE-SEM Publications

Technical group	Tools/techniques	Goals	Usable or not	Explanation
	Andon	Un système visuel permettant de détecter le problème au moment de leur apparition.	Usable	
	100% control	Eviter les non conformités	Usable	
Supply chain management	Spaghetti diagram	Represent the movements of an object or a person in the work environment in order to eliminate unnecessary movements	Usable	It can be used to represent the transfer of information, deliverables or product in the development phases
	VSM	Identify and visualize in a synthetic way all the physical and information flows of a process to identify the mudas	Usable	It is already used in the software field under the name of "Software Value Map"
	SIPOC	Describe the manufacturing process of a product or product family and model the interactions between its stakeholders	Usable	The development of an IT product goes through a process so we can describe this process and the interactions between its stakeholders through a SIPOC diagram
Standardization	5S	Manage space	Can be used	Can be applied to company desks but utility in relation to product is unclear
	Standardized Work	Standardization of tasks	Usable	We can follow a standard to ensure the synchronization of teams
	Visual management	Technique to identify, separate and share, in an obvious way, the normal from the abnormal in order to eliminate waste	Usable	We can set up visual management at the workstation level and can also be applied in the form of dashboards
Work organization	Balancing posts	Technique for balancing workloads	Usable	In the software field, we can balance the time necessary to carry out the tasks granted to each member of the team

IEEESEM

Copyright © 2023 IEEE-SEM Publications

Technical group	Tools/techniques	Goals	Usable or not	Explanation
	Time study/Work	It is a practice applied in order to manage time in relation to work	Usable	It is a managerial practice independent of the type of process
	Downsizing (for reallo-cation)	Technique to reduce the workforce	Usable	The possibility of downsizing is always applicable in all areas

IEEESEM

Copyright © 2023 IEEE-SEM Publications

3 LEAN IT IMPLEMENTATION APPROACH

The case study company has overcome the challenge of integrating a Lean approach in a purely IT environment and has taken a first step towards integrating Lean IT principles into its development process by following the following methodology:
1. Understand the principles of Lean IT: The project team must understand the definition and objective of each principle.
2. Explore and analyze the company's processes: The project team must have a solid understanding of the company's processes to be able to track the different project stages and distinguish value-added tasks from non-value-added tasks.
3. Evaluate the current performance of the company in relation to the application of Lean IT principles: Based on the definition and objective of each principle and the analysis of the company's processes, this step involves assessing whether the objectives of each principle are being achieved in the company's process.
4. Apply Lean IT principles to the company's process: This step involves proposing solutions for each principle that has not been fully implemented and then implementing them.
5. Measure the results: This involves tracking the proposed solutions and measuring the achieved results.

4 EVALUATION OF PERFORMANCE OF THE CURRENT COMPANY'S PROCESS

The objective of our project is to implement the principles of Lean IT described in Section 2.3. Thus, evaluating the current performance of the company consists in evaluating its capacity to apply these principles. Through the observation and analysis of the company's operational process, we discovered that it incorporates several principles of Lean IT. This integration is a result of adopting the Agile method, which aligns with certain principles of the Lean approach. So, we will elaborate on the extent to which the company applies Lean IT principles.

— *Principle 1: Eliminate Waste*

The observation of various activities in the operational process and the conducted meetings have revealed that each task can generate multiple types of waste. This implies that in addition to the wastes mentioned in Section 3.2, there are several other forms of waste. Therefore, implementing this principle requires the use of a tool or practice to identify and eliminate waste. However, this is not currently implemented in the company.

IEEESEM

— *Principle 2: Decide as Late as Possible*

Decision-making is a daily practice that can be either planned or sudden. In both cases, a decision should not be made until we have gathered the maximum amount of information to ensure its reversibility.

In our case, the company has Key Performance Indicators (KPIs) for each process, which are calculated monthly. Every quarter, these KPIs are displayed in a designated area within the company. Decisions are therefore justified and based on this data. This is monitored through internal audits conducted by the quality coordinators in the quality and improvement management department. Hence, the second principle is well implemented at the company.

— *Principle 3: Intrinsic Quality*

The analysis phase of the current state has allowed us to observe that work products or deliverables are not always in conformity with the requirements upon initial delivery. The analysis of the root causes of this problem reveals that its origin lies in the fact that the company lacks an effective problem analysis practice. Therefore, this principle is not well implemented in the company.

— *Principle 4: Amplify Learning*

This principle is implemented in the company by following the principles of the Agile methodology, which require customer integration throughout all project phases. In fact, two development approaches have been followed in the company, either the Scrum framework or the Waterfall methodology. In both cases, the company has drawn inspiration from the Agile approach and involved the customer in different project phases by conducting Demo meetings at the end of each sprint (if the project follows the Scrum framework) or at the end of each version (if the project follows the Waterfall methodology). During these meetings, the team's work is presented in the presence of the customer.

This meeting helps assess the project's progress and its adherence to the acceptance criteria defined at the beginning of the project, as well as improving the understanding of the remaining work. In addition to these meetings, discussions can take place during the execution of sprints/versions. Therefore, this principle is perfectly implemented.

— *Principle 5: Delivering Quickly*

In our case, this principle is not always applied. Indeed, the delivery deadlines set at the beginning of the project are not always met. This should be demonstrated through the Key Performance Indicator (KPI) that measures the number of late deliveries. The problem is that the

Copyright © 2023 IEEE-SEM Publications

responsible individuals reschedule and modify the delivery date when the client accepts the delay, and the KPI is calculated based on the new delivery date. Therefore, this KPI does not reflect the actual delay incurred.

— *Principle 6: Empower the Team*

This principle is applied in the company by following the principles of the Agile methodology. Indeed, the daily meetings, retrospective meetings, and sprint planning meetings are conducted to involve the project team in its various stages and in decision-making processes.

— *Principle 7: Optimize the Entire Value Chain*

In our case, the company has documents that define the workflow in each part of the company's processes. These documents provide a mapping that outlines the tasks to be performed in each process activity, enabling the definition of value and differentiation between value-added tasks and non-value-added tasks. They also facilitate the visualization of interactions between different processes.

The analysis phase of the current state has revealed that the sequence of tasks defined in these workflows is not always followed, resulting in non-conformities and delays between activities, leading to wastage. Therefore, this principle is not well implemented.

The description of the current state of the company shows that it has already taken a first step towards integrating Lean IT principles through the practices required during the execution of its projects. Table 3 provides a summary of the application of Lean IT principles in the company and the proposed solutions for each. This table consists of three columns:

- Principle: This column describes the name of the principle.
- Decision: The analysis phase of the current state allowed us to determine whether the principles were applied in the company. This column reflects this decision.
- Solution: This column is dedicated to the proposed solution for implementing the non-applied principle.

TABLE 3. SUMMARY OF THE CURRENT STATE

Principle	***Decision***	***Solution***
Eliminate waste	Not Applied	Implement a practice for identifying and eliminating waste
Decide as Late as Possible	Applied	-
Intrinsic Quality	Not Applied	Establish a practice for analyzing problems as they arise
Amplify Learning	Applied	-
Delivering Quickly	Not Applied	Implement a waste elimination practice
Empower the Team	Applied	-
Optimize the Entire Value Chain	Not Applied	Implement a waste elimination practice

IEEESEM

The proposed solutions also contribute to further enhancing the implementation of the principles already applied within the company.

5 DESCRIPTION OF THE PROPOSED SOLUTION

The objectives of the proposed solution are:

- Incorporate Lean IT principles into company's process.
- Evaluate the performance of company's process in terms of waste elimination.
- Align with a continuous improvement approach.
- Apply Lean tools within the company's process.

In order to incorporate Lean IT principles, we have consolidated the proposed solutions in Table 3 into a single solution, which involves adding a new practice to the company's operational process.

The solution involves developing an application for identifying and eliminating the nine sources of waste by conducting a root cause analysis whenever a problem arises. The application consists of three phases.

- The first phase involves defining the identified waste during each sprint or version. When a waste source appears, the Agile Master or project manager, who oversees the project throughout its various stages, must describe the waste using the approach defined in the tool. Based on a predefined threshold, the Agile Master/project manager is prompted to define an action and conduct a root cause analysis when necessary.
- The second phase involves assessing the sprint or version. After each sprint/version, the Agile Master/project manager and the project team participate in a retrospective meeting. An evaluation of the frequency of occurrence for each waste will be conducted during this meeting. This evaluation is based on KPIs that visualize the progress of each waste during the sprint/version. These KPIs will be automatically calculated by the application and displayed in the form of graphs.

The third phase involves evaluating the effectiveness of the implemented actions by comparing two consecutive sprints/versions. If the

Copyright © 2023 IEEE-SEM Publications

frequency of waste occurrence increases or remains stable, a root cause analysis is mandatory, including completing the Ishikawa diagram followed by an action plan.

6 EVALUATION OF THE SOLUTION'S PERFORMANCE

The implementation of the solution and the monitoring of the results have enabled the achievement of the set objectives, presented above in Section 5.

6.1 Objective 1: Incorporate Lean IT principles into company's process

The first benefit achieved following the implementation of the new practice is the adherence to principles that are not yet applied in the company's processes.

- Eliminate Waste

Adhering to the approach required by the implemented solution has allowed for the identification of all types of waste that may occur during the execution of any project, regardless of its type. Subsequently, analyses and actions are conducted to prevent the recurrence of the identified waste, resulting in waste reduction.

Therefore, the first principle implemented through the solution is the elimination of waste.

- Intrinsic Quality

This principle has been upheld through:

- ✓ Identifying actions as soon as waste emerges.
- ✓ Conducting a 5 Whys analysis when the frequency of waste occurrence exceeds the threshold.
- ✓ Performing a comparison and Ishikawa analysis at the end of each sprint/version.

These practices have enabled the identification and analysis of problem causes, subsequently eliminating waste related to defects and improving the quality of deliverables.

- Delivering Quickly

The adherence to timely delivery has been achieved by following the approach outlined in the tool. Agile masters and project leaders have implemented actions for any delays that occur during the execution of sprints/versions, which has helped minimize/eliminate project delays.

- Optimize the Entire Value Chain

The decrease in the occurrence percentages of mudas observed between sprints has led to a reduction in non-conformities related to the deviation from workflow processes, thus achieving the desired process optimization outlined in the company's workflows.

This has allowed us to adhere to the principle of "Optimize the entire value chain."

IEEESEM

In addition to implementing these principles, the solution has strengthened the application of already respected principles through the activities of the company's processes. The evaluation of the sprint or version during the retrospective meeting, the analysis, and the team decision-making to eliminate waste contribute to the principle of "Empower the team". Furthermore, the KPIs defined by the application provide data that can help gather information to ensure reversible decisions. Therefore, the principle of "Decide as late as possible" has been reinforced.

Through the application, we have successfully adhered to the principles of Lean IT and taken the initial steps towards achieving the objectives of each principle.

6.2 Objective 2: Evaluate the performance of company's process in terms of waste elimination

This objective is achieved through the KPIs defined in the proposed solution. The evaluation conducted at the end of each sprint/version has allowed us to assess the team members' ability to minimize the occurrence of waste during the sprints/versions and subsequently determine the company's performance in waste elimination.

6.3 Objective 3: Align with a continuous improvement approach

The continuous identification and elimination of waste following the PDCA principle has allowed us to embrace a continuous improvement approach.

6.4 Objective 4: Apply Lean tools within the company's process

The implementation of the solution has enabled the application of Lean tools presented in Table 4.

Copyright © 2023 IEEE-SEM Publications

TABLE 4. LEAN TOOLS USED

Lean tool	*Description*
Gemba Walk	It is a practice used in industries that means "going to the gemba". The company has successfully utilized this tool in the IT domain through participation in meetings and observations made during operational activities.
ISHIKAWA	These are problem-solving tools used to identify the root causes of detected waste.
5 Whys	
Pareto	This is a diagram that allows hierarchically listing problems.
Brainstorming	This is a technique that was used during the implementation of Lean to discuss its different phases, collect and analyze data.
Visual management	This tool was implemented, on one hand, through the dashboards presented in the solution, consolidating the detected waste and corresponding actions. On the other hand, through color codes allowing visualizing the evolution of each muda.

4 CONCLUSION

Lean IT is a powerful approach that aims to optimize processes, reduce waste, and improve efficiency within the IT industry. In this context, we presented in this study a new practice for identifying and eliminating waste. Through this tool, we discovered that operational process activities can generate multiple forms of waste each day. Since we cannot improve a process without understanding its true problems, the first implicit benefit of this practice is its ability to identify all types of potential waste.

Furthermore, this tool allowed us to apply Lean principles that were not being followed within the company, subsequently improving its performance in terms of eliminating all sources of waste through the continuous improvement cycle of the PDCA principle. Considering that implementing the Lean approach requires significant time, the new practice facilitated the integration of this approach into the company's processes and helped users adapt to the waste identification and elimination process. As users become more accustomed to the tool's approach, significant values can be derived to assess the effectiveness of the new practice.

In conclusion, Lean IT provides a framework for optimizing IT processes, reducing waste, and delivering greater value to customers. By embracing Lean principles and fostering a culture of continuous improvement, organizations can enhance their competitiveness, improve customer satisfaction, and drive innovation in the dynamic landscape of the IT industry. Moreover, Lean IT promotes a culture of continuous improvement. It encourages organizations to regularly assess their processes, identify areas for enhancement, and implement changes to drive ongoing progress. This culture of continuous improvement fosters innovation, adaptability, and agility within the IT environment.

Despite the numerous benefits, implementing Lean IT can also present challenges. Resistance to change, lack of organizational buy-in, and limited resources can hinder the successful adoption of Lean practices. Overcoming these challenges requires strong leadership, effective communication, and a commitment to training and empowering employees.

IEEESEM

REFERENCES

[1] F. Kišš and B. Rossi, “Agile to lean software development transformation: A systematic literature review,” *Proc. 2018 Fed. Conf. Comput. Sci. Inf. Syst. FedCSIS 2018*, vol. 15, pp. 969–973, 2018, doi: 10.15439/2018F53.

[2] J. Kobus, “Demystifying lean IT: Conceptualization and definition,” *Multikonferenz Wirtschaftsinformatik, MKWI 2016*, vol. 3, no. March, pp. 1429–1440, 2016.

[3] J. Pernstål, R. Feldt, and T. Gorschek, “The Journal of Systems and Software The lean gap : A review of lean approaches to large-scale software systems development,” *J. Syst. Softw.*, vol. 86, no. 11, pp. 2797–2821, 2015, doi: 10.1016/j.jss.2013.06.035.

[4] N. B. COPLIEN, James O. et HARRISON, “Organizational patterns of agile software development,” 2004.

[5] J. Widman, S. Y. Hua, and S. C. Ross, “Applying Lean Principles in Software Development Process a Case Study,” *Issues Inf. Syst.*, 2010, doi: 10.48009/1_iis_2010_635-639.

[6] B. M. Poppendieck, T. Poppendieck, and P. A. Wesley, *Lean software development: an agile toolkit [Book Review]*, vol. 36, no. 8. 2003. doi: 10.1109/mc.2003.1220585.

[7] P. Middleton and D. Joyce, “Lean software management: BBC worldwide case study,” *IEEE Trans. Eng. Manag.*, vol. 59, no. 1, pp. 20–32, 2012, doi: 10.1109/TEM.2010.2081675.

[8] X. Wang, “The combination of agile and lean in software development: An experience report analysis,” *Proc. - 2011 Agil. Conf. Agil. 2011*, pp. 1–9, 2011, doi: 10.1109/AGILE.2011.36.

[9] B. Swaminathan and K. Jain, “Implementing the lean concepts of continuous improvement and flow on an agile software development project: An industrial case study,” *Proc. - Agil. India 2012, Agil. 2012*, pp. 10–19, 2012, doi: 10.1109/AgileIndia.2012.12.

[10] “Kupiainen , E ., Mäntylä M . V ., Itkonen J ., " Using Metrics in Agile and Lean Software Development - Using Metrics in Agile and Lean Software Development – A Systematic Literature Review of Industrial Studies,” 2015.

Copyright © 2023 IEEE-SEM Publications