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A Taxonomy of Lean Six Sigma and Agile Methodologies used in Software Development

Safia Badwe and Turan Erman Erkan

Department of Industrial Engineering,
Atilim University, Ankara, Turkey.

Abstract

Six Sigma is a business reasoning that highlight ongoing change, in light of a factual measure of instability. Lean is a persistent system to enhance execution, concentrating on waste disposal. Agile is methodology for extend administration, which can be utilized to control programming and item improvement utilizing redundant practices. This methodology can fundamentally build efficiency and decrease time to market. For the most part, lean and Six Sigma concentrate on taking out waste and giving the most elevated quality items and administrations with minimal cost, while encouraging an effortless, quick improvement approach. In this study, we will survey the existing literature in Six Sigma, Lean, Lean Six Sigma and Agile strategy over the past ten years. We analyze published research in the ranges of programming improvement. The audit is construct just with respect to the forty six (review) articles published between 2003-2017 academic literature

Keywords- Six Sigma, Lean, Lean Six Sigma, Agile, Software Development

I. INTRODUCTION

The fast extension of information communication and information technologies in all fields of business creates pressure to maximize the use of the software development process. More than ever before, the relationship between quality, cost, and delivery time has turn into a crucial condition for god speed. Developing software products at competitive costs that meet fantastic measures and are in accordance with tight, even same-day, deadlines has become a daunting task. In addition, software development is often constrained by strict documented procedures that require strong monitoring mechanisms, creating a need for additional development operations in project management software [1].

Software development is a standout amongst the most complex errands performed by people. It has become increasingly challenging, particularly in recent as the size and multifaceted nature of programming frameworks has developed, making it harder to coordinate the work of multiple developers [2]. A growing number of software developers are participating in typical software development projects, whether distributed or global, as well as in new opportunities provided by networking technologies. In other words, one of the chief innovations is the ability of communications technologies to allow larger numbers of people to be involved in the project, even across different continents, time zones, and languages.

I.I . Six Sigma

Six Sigma is a business philosophy focusing on continuous improvement [3] Six Sigma approach gives and applies a gathering of different statistical instruments to group and to pick methodical devices prompting the flawlessness of the item and the fulfillment of client [4].The term “Six Sigma” refers to an approach which offers to enhance the efficiency of the money making companies’ implementation. In other words, it is the process which is deemed fundamental for any development efforts. A process is divided into a product process or service process offered by the company either from the inside or the outside .As for instance billing process or production process. The main objective of the process of optimization is to enhance the effectiveness and at the same time reducing the contrast degree of performance. Consequently, this results in diminishing the inequities and growing the profits and staff standards, which ultimately causes business to reach the state of excellence [5].

These methodologies or approaches consist of five stages and each of them is with DMAIC (Definition, Measure, Analysis, Improve and Control) and DMADV (Definition, Measure, Analysis, Design and Verify) stands maintaining the viewpoint that “it's high power lies in its "empirical", data-based method and the datum that it emphases exhausting quantitative measures of how the system is acting in attaining the aim of the process enhancement and difference lessening" [6]. The quality of Six Sigma approach is Six Sigma staff groups who work fundamentally on the Six Sigma venture and has an aptitude of Six Sigma for process change. Moreover, Six Sigma staff groups can utilize nearly time to oversee issues of activities prompt a brief timeframe of finishing venture [4].

I.II. Lean

Lean approach concentrates on examination and disposing of seven wastes on all through the entire procedure. In addition, it influences happening nonstop stream and smooth process in each branch of plant, for example, outlining division, obtaining office, fabricating office, conveyance, administration amid the day incorporate correspondence amongst producer and client [4]. Its fundamental subject is maximizing the value of clients and reducing the waste. In other words, the chief objective is valuing customers with the assistance of scarcer assets. Moreover, a lean

organization is the one that profoundly realizes customer values and make it its own concern to achieve them on persistent basis [7, 8].

In the industrial sector, the word muda in Japanese means waste, and has many interpretations? As for instance material form, unexploited potential, joblessness and inventory. Lean means concern, therefore, is the exclusion of such waste of non-value actions, chores, tools and assets in general. Realizing the statement that 70% of a company's resources might represent its own waste, stresses the perseverance for taking the situation very seriously and paves the way towards the execution of numerous lean industrial practices [9]. The estimation of the item or service is clearly defined by the principles of lean according to the insight of customers. At that point, efforts are made for attracting customers and striving for achieving precision and exactness to eradicate waste via extrication value added activity(VA) and non- value added activity (NVA) [9, 10].

I.III Lean Six Sigma

Lean assembling is one of the activities that real organizations all around the globe have been attempting to embrace with a specific end goal to remain competitive in the undeniably worldwide market this is while Six Sigma was an American "innovation". The Central thought behind Six Sigma is that if you can gauge what number of "defects" you have in process, you can deliberately make sense of how to eliminate them and get as near "Zero Defect" [11]. Lean considering and Six Sigma have been used by assembling businesses to diminish cost, enhance quality, and efficiency by reducing variance in production defects [4].

Recently, Lean Six Sigma has come to existence as a result of combining Six Sigma ideas with lean manufacturing. Six Sigma is concerned with the dissimilarity and design, harmonizing corrections intended for boosting "business and 'operational effectiveness." Businesses such as GE, Verizon, Jeenba kt and IBM have been utilizing Lean Six Sigma to strengthen alteration exertions on both competence and development. It has been considered and recognized as the innovation foundation intended for the organization, from industrial and growth of deals and service provision software [12].

George (2002) has published the concept of Six Sigma and provided a definition for it as follows:" Lean Six Sigma is nothing but a method for increasing shareholders value through accomplishing the quickest degree of enhancement concerning customer fulfillment, fulfillment, price, excellence, process swiftness, and capitalized money". Expressions such as "Lean Six Sigma" are heard quite often; with cumulative frequency to advance the process necessitates features of both methods to safeguard affirmative outcomes [13, 14].

I. IV Agile

Agile approach concentrate on the adaptability and flexibility portrayed as elegant; dissimilar the traditional processes that are required to make changes [15]. Agile implementation is a very different approach from the traditional one. In any case, all the Agile strategies don't satisfy all the quality factors. Otherwise one methodology may satisfy the multiple quality assurance factors [16]. Agile methodologies can be used for growing little and straightforward programming's as well as they are appropriate for advancement of immense and complex IT frameworks. Agile methodology is progression relies upon the likelihood of incremental and iterative improvement in which stages inside advancement cycle are returned to again and again [16]. Agile practices have a huge effect in developing software in recent few years. A fair amount of affirmative response has been noted from organizations that use Agile practices. These practices are quite popular for producing evolving software's [17]. The 12 principles behind the Agile Manifesto provide the software development teams with an in-depth understanding of what Agile software development is all about. Understanding these principles allows development teams to uphold the Agile values during software development [15, 19].

The goal of Agile methods to adapt to changing needs, and reduce development costs, and continue to provide quality and reasonable software. With fast projects with several releases all born in a very short period of extra time. Normally, all team members involved in all aspects of planning, implementation, and testing. This is generally used by small teams, maybe nine or less, which can be a daily interaction and face-to-face. They may include representative teams of the customers. There is a strong emphasis on testing as it is written software [8]. Cover, media and all peoples required to complete the program. At a minimum, this incorporates software engineers and individuals who know the item, for example, item administrators, business examiners, or real clients. It might incorporate relievers what's more, trying, interface fashioners, specialized essayists, and administration. Also, confirms the flexibility of the working methods of the program essentially a measure of advance. With a predilection to communicate face to face and Agile strategies produce very little written documentation relative to other strategies [20].

I.V. Lean and Six Sigma as Applied to Software

Lean and Six Sigma practices are appropriate in many cases. Lean and Six Sigma strategies have been successfully connected to assembling segment for over two decades. There is an aggregate delusion that Six Sigma is substantial for industry area as only. The solicitation of Lean Six Sigma in programming organizations has gone up against endless contradictions. There are different various elucidations on applying Six Sigma in software companies [21]. It is enormously noteworthy that those applying Lean Six Sigma practices in programming advancement circumstances clearly grasp the relationship amongst programming and exemplary lean balanced [22].

Six Sigma and Agile both are sorts of procedure, Six Sigma is process change procedure while Agile is software development system. Applying Six Sigma in a procedure we expect to enhance process ability by diminishing the varieties (controlled) during the process. In any case, applying Agile strategy in a software development process. We don't expect to decrease process varieties yet plan to achieve incremental improvement by empowering fast and adaptable reaction to changes. Be that as it may, we can simply utilize a portion of the prescribed procedures of dexterous like scrum gatherings while actualizing Six Sigma and a few apparatuses of Six Sigma like FMEA (Failure Mode Effect Analysis) in Agile.

II. RESEARCH METHODOLOGY

Inside this paper performed a range of survey to summarizing literature in this area. We advanced Literature audits since they are great sources of information for patterns in programming advancement. The existing literature demonstrate where individuals are concentrating their exploration and will give a sign of future research patterns.The writing survey investigation began from collection of the articles on the theme of interest.

The philosophy utilized by the authors has been set up by utilizing the ISI Web of Knowledge databases. The writers were searching for articles with the "Six Sigma, Lean, Lean Six Sigma and Agile "Keyword" in the primary subjects (title, abstract, keywords). An aggregate of 46 articles have been gathered, in this writing study, we used Systematic Taxonomy of Literature Review (Table I), this has been taken from journal, conference proceedings and organization studies from different them under (IEEE, ISSN, Science direct, act...).

The objective of this article was not to investigate the intercessions themselves, so the level of data separated was not to the profundity of extremely thorough precise relative surveys. We refer interested readers for detailed discussions to the original publications.

Author	**Year**	**Journal**	**Title**	**Focus**	**Methodology**
Thomas M. Fehlmann	2004	Semantic scholar, Allen institute for artificial intelligence	Six Sigma for Software	The Six Sigma application for software development makes software ventures straightforward to both administration and clients. Straightforwardness requires a noteworthy social change. Subsequently, after a check of transparency, and finalization of the precise estimates of the project during a meeting, both deadlines and customer requirements are much simpler.	Six Sigma

Author	Year	Journal	Title	Focus	Methodology
Thomas M. Fehlmann	2010	Semantic scholar, Allen institute for artificial intelligence	Six Sigma for Agile Teams	In this work, a set of techniques are utilized in Six Sigma to complete the task. In this respect, deploying quality in different functions becomes important and making Agile development progress in operations even more so. It the transfers the functions of the Six Sigma map in order to develop practical responses to project control issues. The results are valid for all types of lean software development.	Six Sigma, Agile
Thirunadana Sikamani K. Surend Raj Dharmapal	2016	International Journal of Applied Engineering Research	Using Key Six Sigma and Lean Metrics on Agile Scrum Methodology for Performance Improvement	Both the Six Sigma custom application of Lean standards and the Agile Scrum model help to identify and resolve certain defects as soon as possible and in an efficient manner.	Six Sigma, Lean, Agile
SurendRaj Dharmapal	2014	International Journal of Advanced Research in Computer Science and Software Engineering	Integrating Six Sigma Tools on Agile Scrum Methodology	This journal seeks to bring into light better ways to integrate the tools of Six Sigma projects in the Scrum Agile methodology. By applying the Six Sigma Scrum tool models, it helps to improve the general status of quality and optimum results for clients in various projects.	Six Sigma and Agile Scrum
Antonio Carlos Tonini, Mauro de Mesquita Spinola, and Fernando José Barbin Laurindo	2006	IEEE	Six Sigma and Software Development Process: DMAIC Improvements	This paper recommended upgrades in the DMAIC strategy. Some of the topics tackled in this work include the following: cost assessment, the impact of time and consumer loyalty in business, confirmation of potential changes in forms, hierarchical institutionalization, and learning from accomplishments of Six Sigma-related projects. The primary outcome is the proposition of a detailed guide for Six Sigma venture applications in programming changes throughout the	DMAIC

Author	Year	Journal	Title	Focus	Methodology
				development cycle when treating detected angles.	
Adnan Rafiq Khan	2008	Conference: Proceedings of the 7th International Conference on Software Engineering, Parallel and Distributed Systems (SEPADS'08),	Applying Six Sigma in Software Companies for Process Improvement	The work presents the Six Sigma concept as identified and implemented throughout the industry. To this end, numerous interviews and case studies are conducted with a view to assist software development companies in better applying the Six Sigma approach.	Six Sigma
Antonio Carlos Tonini, Mauro de Mesquita Spinola, and Fernando José Barbin Laurindo	2007	IEEE	An Application of Six Sigma with Lean Production Practices for Identifying Common Causes of Software Process Variability	This paper is an attempt to examine the benefits of utilizing Lean Production hones in view of a various contextual investigation on some software organizations that utilization this philosophy. The investigation demonstrates that related activities can be carried out more rapidly, thanks to this approach, and that more effective outcomes can be yielded.	Six Sigma and lean
Karan Wadhawan, Twinkle Sharma and Sujata	2014	International Journal of Information and Computation Technology.	Amalgamation of Six Sigma and Agile	Concerning the Agile methodology, it is maintained that it can address issues by utilizing an iterative and incremental approach. As to Six Sigma, one of the essential targets is to adjust business objectives to the necessities raised by clients. As such, the DMAIC (Define, Measure, Analyze, Improve, and Control) stages are implemented in this direction by offering specific apparatuses to address them. Two prevalent Agile methodologies, Scrum and Extreme Programming, are also addressed in this paper alongside many other widely acknowledged and common issues in Agile software development.	Scrum , Extreme Programming and DMAIC

Author	Year	Journal	Title	Focus	Methodology
Jiju Antony and Craig Fergusson	2015	Managerial Auditing Journal	Six Sigma in the software industry: results from a pilot study	This study reports the after-effects of a Six Sigma pilot overview conveyed in the software industry by establishing the CSFs as essential for the compelling course of Six Sigma in programming business. This survey was conveyed outwit a few limits, for example, the number of organizations took part in the survey, available exchequer, time requirements, and so on. Attributable to time constraint, a postal investigation was carried out for this survey.	Six Sigma
Zhedan Pan, Hyuncheol Park, Jongmoon Baik,Hojin Choi	2014	14th Asia-Pacific Software Engineering Conference	A Six Sigma Framework for Software Process Improvements and its Implementation	In this paper, a structure is proposed to help Six Sigma ventures for consistent process enhancements for software development. With this in mind, an electronic device is created, called SSPMT coordinated with a product extend administration device and a PSP supporting apparatus. The proposed system and SSPMT is helpful in starting and executing Six Sigma ventures, encouraging data gathering and data analyses by the respective toolboxes and institutionalizing the Six Sigma extend execution process in order to achieve the corresponding objectives as well as those of the business enterprise applying the system.	Six Sigma
I. Sinovčić, L. Hribar	2010	IEEE	How to improve software development process using mathematical models for quality prediction and elements of Six Sigma	The paper is an attempt to examine the management of programming quality-related procedures and diverse connected models in various development tasks while blaming existing pointers. Three contextual investigations are exhibited and assessed to devise the anticipated programming	Six Sigma

Author	Year	Journal	Title	Focus	Methodology
			methodology	quality on larger development inside the AXE stage utilizing SIP as a call-control convention in the Ericsson Nikola Tesla R&D.	
Cvetan Redzic, Jongmoon Baik	2006	IEEE	Six Sigma Approach in Software Quality Improvement	In this study, related data is analyzed with an eye to make the best choices when figuring out which new advancements (apparatuses, techniques, measures, preparing) ought to be actualized and regulated so as to achieve the objectives. To quantify the change from Six Sigma process transforms, the authors estimated the procedure capacity baselines in view of strategic changes, and followed and assessed continuous programming item quality on a constant basis against the established baselines. This is done to guarantee that the product item quality objectives are, in essence, accomplished as arranged for the purpose.	DMAIC
Farhana Rizvi&Malik Sikander Hayat Khiyal	2015	International Journal of Computer Applications	Sustainability In and for Software Engineering with Six Sigma	Using the insights proposed in this paper, it is asserted that clients can tackle certain matters, such as customary programming and building routines, in order to raise the standards required within and for the purpose of supportability. To do this, Six Sigma is used for the mainstays of programming design within the scope of five interconnected spaces environment, economics, politics, social affairs and, finally, technologies. The outcomes highlighted, upon the use of the enhanced measures, are as follows: improvement in Sigma Level as expanded to 3.9(corresponding to enhanced process yield of 99.19%) from 3(previous process yield of 90.01%). As	Six Sigma

Author	Year	Journal	Title	Focus	Methodology
				is commonly known, the higher the Sigma level, the better the procedure appears to perform and the lower the likelihood that an imperfection will happen.	
Punitha Jayaraman, Kamalanatha n Kannabiran, and S.A.Vasantha Kumar	2013	International Journal of Mining, Metallurgy & Mechanical Engineering (IJMMME)	A Six Sigma Approach for Software Process Improvements and its Implementatio n	This study manages the use of the Six Sigma system in lessening defects in support extends inside the software development. In detail, exertion is made to decide how software process can utilize an efficient approach to move towards world-class quality level.	DMAIC
Rafa E. Al-Qutaish And Khalid T. Al-Sarayreh	2008	7th Wseas Int. Conf. On Software Engineering, Parallel And Distributed Systems	Applying Six-Sigma Concepts to the Software Engineering: Myths and Facts	From two main perspectives, the six-sigma ideas are proposed by this paper to be connected to product designing with the addition of some customization. Furthermore, it is asserted that applying six sigma to the programming procedure could be stretched out to the product item itself by means of changing the item quality attribute esteems into sigma esteems for a wide range of programming alternatives.	DMAIC, DMADV, IDOV
G.Y. Hong and T.N. Goh	2003	The TQM journal	Six Sigma in software quality	In this paper, the materialness of the Six Sigma structure is examined pertaining to programming matters. Some myths and realities about the Six Sigma Software Program (6SSP) are addressed. Likewise, some common confusion is dealt with by the authors regarding the capability of Six Sigma in programming along with certain actual commonsense challenges.	6SSP
K Selvi1 and Rana Majumdar	2014	International Journal of Advanced Technology in Engineering and Science	Applying Six Sigma Techniques To Reduce The Number Of Defects Of	Through this work, certain insights are shared as to the continuous change in the nature of the NextGen programming subsequent to actualizing Six Sigma	DMAIC

Author	Year	Journal	Title	Focus	Methodology
			Software	techniques. An organized and methodical approach is proposed for lessening the imperfections in the testing stage. The Sigma esteem is likewise enhanced from 2.58 to 3.2 as completed in the control stage. In this manner, Six Sigma tasks are genuinely undertaken, thereby demonstrating the productivity and adequacy of the approach.	
Maryam Shahzeydi and Taghi Javdani Gandomani	2016	International Journal of Software Engineering and Technology	Adding lean principles to Agile software development: A case study report	This paper introduces a report of contextual investigations, in which Lean speculation standards have been added to Scrum rehearses. The underlying outcomes demonstrate that there exists a major cooperative potential in between Scrum and Lean practices. Yet, the Scrum group is shown to fall short of the ability to satisfy a portion of the Lean practices; for example, measure and practice, and Kaizen.	Lean and Agile methods
Jeff Widman, Stella Y. Hua, and Steven C. Ross	2010	Issues in Information Systems. Volume XI, No. 1, 2010	Applying Lean Principles In Software Development Process – A Case Study	This paper portrays lean intuition ideas alongside the way toward applying lean in specialized coding at IMVU-a virtual organization. The lessons learned in the execution of lean for software development forms are also introduced in a concise manner in this paper.	Lean Principles
Er.Kirtesh Jailia , .Sujata , Manisha Jailia , and Manisha Agarwal	2011	International Journal of Software Engineering and Its Applications	Lean Software Development (“As a Survival Tool in Recession”)	This research focuses on how to support businesses experiencing a retreat by means of lean programming. As a conclusion, it is asserted that the lean programming advancement approach is the best and is to be utilized as a viable apparatus for ultimate survival when faced with recession in business. This is supported as lean offers speedier improvements while keeping up the quality of the	Lean software development

Author	Year	Journal	Title	Focus	Methodology
				software organization amid retreat.	
Pilar Rodríguez, Jouni Markkula, Markku Oivo, and Juan Garbajosa	2012	O. Dieste, A. Jedlitschka, and N. Juristo (Eds.): PROFES 2012, LNCS 7343, pp. 145–159, 2012.	Analyzing the Drivers of the Combination of Lean and Agile in Software Development Companies	This study shows the after-effects as regards a research among 408 programming professionals from 200 programming organizations in Finland, which is one of the early adopters of Lean for software development. The outcomes feature the enthusiasm of programming experts in embracing a blend of Agile and lean standards to accomplish both adaptability and sparing effectiveness. It is demonstrated that, quite different from what is happening in manufacturing, the change in the field is in essence being directed as a single excursion, in which the boundaries between Agile and Lean are not as clearly and definitively characterized.	Lean thinking, lean software development and Agile
Michael Lane, Brian Fitzgerald and Pär J. Ågerfalk	2012	Conference: 20th European Conference on Information Systems	Identifying Lean Software Development Values	The motivation behind this paper is to recognize center LSD esteems that 'characterize' LSD as much as the coordinated pronouncement esteems bound together along with a series of recommended lightweight strategies for ASD. The standards are observed from different sources concerning lean speculation in various areas. Upon proper arrangement of such standards, an applicable set of lean esteems are introduced so as to define and characterize LSD.	Lean software development
Rahul Vylen, N. Rajesh Mathivanan, N. Shashidhar Chandrasekhar	2013	International Journal of Lean Thinking Volume 4, Issue 1 (June 2013)	Application of Lean Strategy to Redesign the Assembly Process Flow of Glow Plug	This paper addresses the use of lean standards in a car parts manufacturing enterprise with focus on current assembling rehearses and visual distinguishing of non-value-added time, for example bottle necking, holding up time,	Lean

Author	Year	Journal	Title	Focus	Methodology
				dealing with material, and so forth. This venture uses Lean apparatuses, for example "Six Sigma" and Value Stream Mapping" methods. The outcomes reveal an unanticipated increment in profitability by 87% from a previous 82%, thereby lessening dismissals by 13% from 18%, decreasing the assembling lead time by 2.62 days/annum, reducing shop floor space occupation by 6m2 and, furthermore, the assembling cost by 1.16 million INR per year.	
Hun Guo, Taiyong Wang, Dunwen Zuo, Zijing Wang, Jun Li and Ji Xu	2016	Arab J Sci Eng (2016) 41:997–1014	Design and Application of New Quality Improvement Model: Kano Lean Six Sigma for Software Maintenance Project	This study addresses the different restrictions that still exist in the software development, and another quality change model is devised to upgrade programming quality without expanding exertion, cost, and time. To accomplish a product venture of expected quality, another change is proposed, namely Kano Lean Six Sigma display (KLSS), which is utilized to determine correct pre-requisites for the product.	ISS
Anil Kumar Raghavan Pillai, Ashok Kumar Pundir, Ganapath	2014	Journal of Software Engineering and Applications	Improving Information Technology Infrastructure Library Service Delivery Using an Integrated Lean Six Sigma Framework: A Case Study in a Software Application Support Scenario	The purpose of this work is to investigate the application of integrated programs support services, Lean Six Sigma, and to evaluate the benefits of continuous improvement of services in ITIL.	LSS

Author	Year	Journal	Title	Focus	Methodology
Anil Kumar Raghavan Pillai , Ashok K. Pundir, L	2012	Global Journal of Flexible Systems Management	Implementing Integrated Lean Six Sigma for Software Development: A Flexibility Framework for Managing the Continuity: Change Dichotomy	This work focuses on Six Sigma programs integrated into Lean manufacturing in practice, with the expectation that the outcome methodology can help software companies to achieve improvements in terms of costs, deadlines, and quality.	LSS
Kamran Ghane	2014	IEEE	A model and system for applying Lean Six Sigma to Agile software development using hybrid simulation	The model system presented in this research applies Six Sigma methodologies in WFP operations using hybrid simulation, offering relatively detailed empirical information that develops software Agile and lean methodologies for product simulation in future activities. The resulting data can be used not only to improve the process, but to evaluate the effects of factors such as outsourcing, geographic-basis cost, and time difference in process quality.	LSS
Thiago Ferraz V. da Cunha, Valeria L. L. Dantas, and Rossana M. C. Andrade	2011	IEEE	SLeSS: A Scrum and Lean Six Sigma Integration Approach for the Development of Software Customization for Mobile Phones	This study proposes SLeSS, a coordination approach of Scrum and Lean Six Sigma utilized as a part of genuine ventures to create programming customizations for cell phones. This approach empowers execution of operations while realizing quality targets, thereby helping to continuously enhance the improvement procedure and the results of the ventures undertaken by software companies.	LSS and Scrum
Hun Guo, Taiyong Wang, Dunwen Zuo, Zijing Wang, Jun Li and Ji Xu	2016	ISSN: 1662-9795, vd 693	Application of Lean Six Sigma Methodology in Software Continuous Integration	This study reveals how LSS apparatuses help programming R&D groups to enhance item quality and decrease improvement costs. This is because the LSS usage significantly affects the	DMAIC

Author	Year	Journal	Title	Focus	Methodology
				financial aspect of operations in enterprises. It is demonstrated that the overall nonstop incorporation (PCI) achievement proportion (3 months normal) is expanded from 27% to 74%, bringing about roughly 56.87K Euros worth of savings in such costs for this task. At long last, some key achievement factors that are basic to the execution of a compelling Green Belt program are analyzed, and administrative ramifications are given.	
ShubhinderKaur, Er. Amanpreet Kaur	2015	International Journal of Advanced Research in Computer Science and Software Engineering	Process of Moving from Traditional to Agile software Development: A Review	The work examines the waterfall model and XP and by making a comparison between the two to show their features and defects.	Agile software development, Extreme programming, Waterfall
Maria Sagheer, Tehreem Zafar, and Mehreen Sirshar	2015	International Journal Of Scientific & Technology Researc	A Framework For Software Quality Assurance Using Agile Methodology	The paper summarizes how to achieve quality assurance in the field of Agile software development utilizing distinctive components. The objective of this work is the parameter that guarantees quality in the Agile analysis approach. A brief description is provided of the standards that ensure optimum quality.	Agile
Gaurav Kumar and Pradeep Kumar Bhatia	2012	International Journal of Computer Technology and Electronics Engineering (IJCTEE)	Impact of Agile Methodology on Software Development Process	In this article, the effects of Agile strategies are investigated in different software development forms as to quality throughout the organizational, efficient, and social system framework. A number of elements are introduced with a specific impact, directly and indirectly, on the improvement of ventures having coordinated structures.	Crystal Method, Extreme Programming, Feature Driven Development, Scrum and Test Driven Development.

Author	**Year**	**Journal**	**Title**	**Focus**	**Methodology**
Riffat Naz and M. N. A. Khan	2010	International Journal of Software Engineering and Its Applications	Rapid Applications Development Techniques: A Critical Review	In this work, a detailed review is provided of the literature for maintenance techniques of existing products, whit new proposals and technical models for product maintenance and analysis R&D using the Scrum methodology. Utilizing RAD approach to create programming requires least getting ready for fast prototyping. It devours lesser time and delivers quality software however that quality software is reasonable for small to medium size ventures. At the point when RAD strategies are utilized for huge or complex ventures, it can't gives required outcomes	Scrum, Extreme Program and Rapid Application Development
Raoul Vallon, Lukas Wenzel, Martin E. Brüggemann, Thomas Grechenig	2015	Journal of Software doi: 10.17706/jsw.10. 11.1245-1264	An Agile and Lean Process Model for Mobile App Development: Case Study into Austrian Industry	This research addresses the distinguished works and drafts of Agile processes by revealing that it can contend with the necessities of the present market. The ALP-versatile model and Agile and lean processes for portable application advancement joins components of Scrum, Kanban and Extreme Programming (XP). The outcomes of the research help, through discussions with field experts, to facilitate more practical and constructive evaluations for future studies to combine these models.	Kanban,Scrum and XP
Raja K, Saba N, Fakhar A,Naila I, Memoona H	2016	International Journal of Software Engineering &Applications (IJSEA), Vol.7, No.3	A Review Of Security Integration Technique In Agile Software Development	In this study, extensive work is carried out in order to shed light on the existing security problems in the field of Agile software development. It shows that most of the challenges announced in the literature came about because of the lack of involvement of security experts. In this way, one can enhance software security without harming the true essence of activities by	Agile

Author	Year	Journal	Title	Focus	Methodology
				engineers, allowing continuous participation throughout the cycle of development and bearing in mind the function and specific responsibilities assigned and to be undertaken in each cycle.	
Rostislav Fojtik	2010	Since Direct	Extreme in Programming development of specific software	In this paper, experiments using Extreme Programming (XP) for specific projects are shown. The suitability of the use of Agile software development methods for particular applications is examined as to users suffering from certain disorders. The advantages and disadvantages of new methodological programs, especially extreme programming, are discussed.	Extreme Programming, Agile, VOKS
Veselin Georgiev and Kamelia Stefanova	2014	Economic Alternatives, Issue	Software Development Methodologies for Reducing Project Risks	This work introduces a new family of software development methodologies and regards Agile processes as able to address the difficulties of future improvements in the software industry. These methodologies concentrate on the adaptability and versatility and are described as elegant, not at all like the traditional processes that are required to roll out improvements. The use of these procedures and practices react to the need in the industry to decrease hazard and increment quality and ease of use of the last programming item.	SCRUM, Feature Driven Development, Adaptive Software Development **,** Agile**,** Extreme programming
Matthias. E and Johannes. F	2016	8thInternational Conference, SWQD , Vienna, Austria	How Scrum Tools May Change Your Agile Software Development Approach	This paper describes extensive interviews carried out with selected masters of scrum method who explained the existing tools and spaces in light of actual needs and necessities of clients. It is also discussed how the tools can be used in Scrum effectively to provide for a possible advantageous concepts in the efforts to make improvements.	Scrum , Agile

Author	Year	Journal	Title	Focus	Methodology
Timothy Haig-Smith and Maureen Tanner	2016	Issues in Informing Science and Information Technology Volume	Cloud Computing as an Enabler of Agile Global Software Development	The focus of this paper is on 12 rules that underlie all Agile strategies and which can enhance the chances of better-quality outcomes.the research involves contextual analysis, with the results showing that a portion of the difficulties in the use of Agile standards in AGSD can be overcome using CC.	Agile, Scrum
Harleen K. Flora and Swati V. Chande	2014	(IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (3)	A Systematic Study on Agile Software Development Methodologies and Practices	This study clarifies the qualities and standards of ten Agile practices that are increasingly appealing mainstream in the software development industry. It is argued that Agile procedures are not generally useful and that they have a few constraints too, concluding that both favorable and undesired circumstances and qualities are to be taken into account when applying Agile procedures.	Agile
Tasneem Abd El Hameed, Mahmoud Abd EL Latif, Sherif Kholief	2016	International Journal of Advanced Computer Science and Applications	Identify and Classify Critical Success Factor of Agile Software Development Methodology Using Mind Map	In this study, a subjective report is presented concerning the basic elements of progress from past studies. The components of progress are coordinated with other relative standards to show the most profitable factors for Agile approach achievement. This paper additionally demonstrates that twelve standards have been inadequately recognized as main elements and due to subjective and quantitative past investigations. In this respect, measurements and factors are introduced utilizing critical achievement dimensions and the factors mind map model.	Agile
Jiangping Wan, Ruoting Wang	2010	Software Engineering & Applications, 1131-1140	Empirical Research on Critical Success Factors of	In this paper, learning creation hypothesis is applied to examine an open-source programming group with effective utilization of the	Agile

Author	Year	Journal	Title	Focus	Methodology
			Agile Software Process Improvement	common lithe programming strategy, thereby coming up with ten standards of knowledge creation, namely: Self-sorting out, Code - sharing, Adaptability, Sustention, Interaction, Communion, Talent, Excellency, Usability and Democracy.	
malik Hneif, siew Hock Ow	2009	International Journal of Research and Reviews in Applied Sciences	Review Of Agile Methodologies In Software Development	This study shows a survey of three nimble methodologies and depicts the contrasts amongst them and prescribes when to utilize them. These systems display ideal outcomes when there is solid correspondence between the developer and the client, and when the advancement group bargains with talented team members. At the point when there is a chance for major misunderstandings of client's actual needs, or when the due dates and spending plans are tight, Agile procedures are shown to be among the best software development ways to deal with projects.	Extreme Programming, Agile Modeling, and SCRUM
Martin Tomanek and Tomas Klima	2015	International Journal on Cryptography and Information Security (IJCIS), Vol. 5, No. 1, March 2015	Penetration Testing In Agile Software Development Projects	Here, the authors propose how the coordinated programming advancement structure Scrum can be improved by considering the infiltration tests and related security necessities throughout the software improvement life cycle. The main focus is on the improvement of new data framework entrance test procedures, PETA, and on utilizing COBIT 4.1 as the structure for the administration of these tests as well as on efforts in the past to fit the task administration system PRINCE2 into Scrum. The results of this study can be utilized basically by the security administrators, clients, designers and	Scrum Agile

Author	Year	Journal	Title	Focus	Methodology
				evaluators.	
A. Ahmed ; S. Ahmad ; N. Ehsan ; E. Mirza ; and S. Z. Sarwar	2010	IEEE	Agile software development: Impact on productivity and quality	This investigation contains a quantitative examination of the Agile philosophies and the advantages related with them. The work is carried out on a characterized set of traits that bring about expanded efficiency and enhanced quality through the utilization of these strategies. The experimental research directed in this paper reiterates these improvements.	Agile
Malek Al-Zewairi, Mariam Biltawi, Wael Etaiwi, Adnan Shaout	2017	Journal of Computer and Communications, 2017, 5, 74-97	Agile Software Development Methodologies: Survey of Surveys	In this examination, 26 studies were chosen for audit and assessment purposes by utilizing another proposed investigative procedure called "Think about and Survey". The procedure is characterized into four classes "Agile Requirements Building", "Agile Methods", "Hybrid Agile Methods" and "Accidental". Besides, four recently proposed deft procedures are assessed, demonstrating that the vast majority of the overviews were proposed in 2015, and that the most studied class was the Hybrid Agile techniques.	Agile

Table I is a summary of a number of papers published in the development and industry of software using the methodologies selected in this study.

III. SUMMARY OF REVIEW AND DISCUSSION

In this part, we will have a brief description about the literature trends, distribution of published papers by different methods, chronological distribution of the research papers and distributed of journals sponsored by different societies of area derived from tables above. There is also compare between methodologies which focuses on the subject of the study.

III. I .Literature Trends

Fig(1), Indicated the papers in these categories provided a general description of Six Sigma and percentages on these topics were 23.9%, 6.52%, 7.81%, and 36.96% for

Lean, Lean Six Sigma and Agile respectively, and lower rates for the rest.

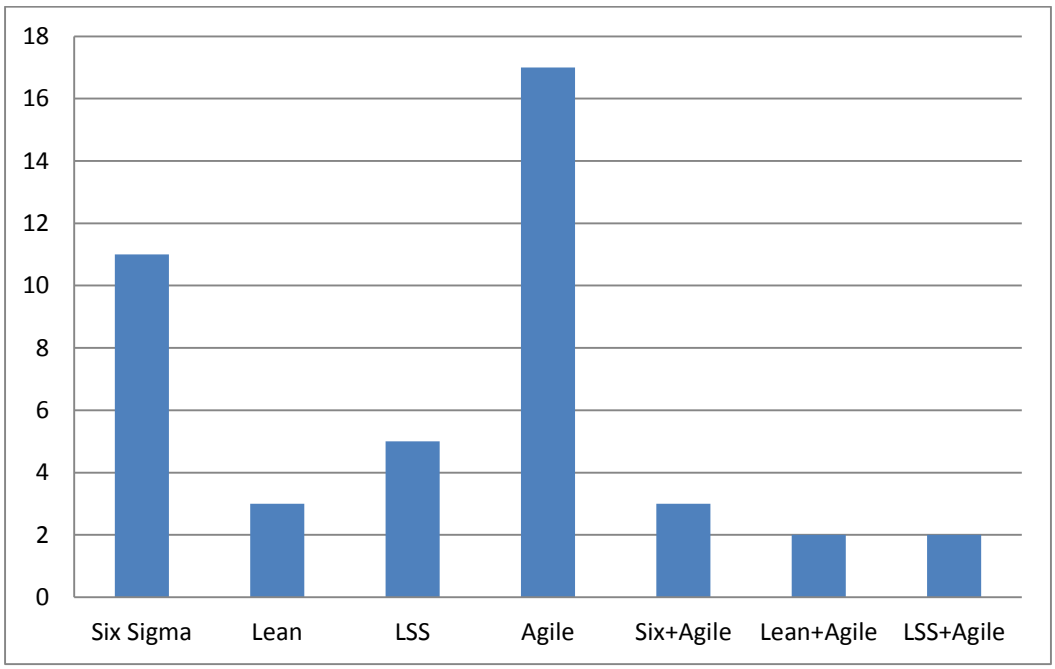

Fig.1. Distribution of published papers by different method

As should be obvious from the fig (2), there have been a noteworthy number of articles published in (Six Sigma, Lean, Lean Six Sigma and Agile) journals with this subject. What is much all the more fascinating is the number of published papers has expanded fundamentally especially in the previous 8years (2010 – 2017).

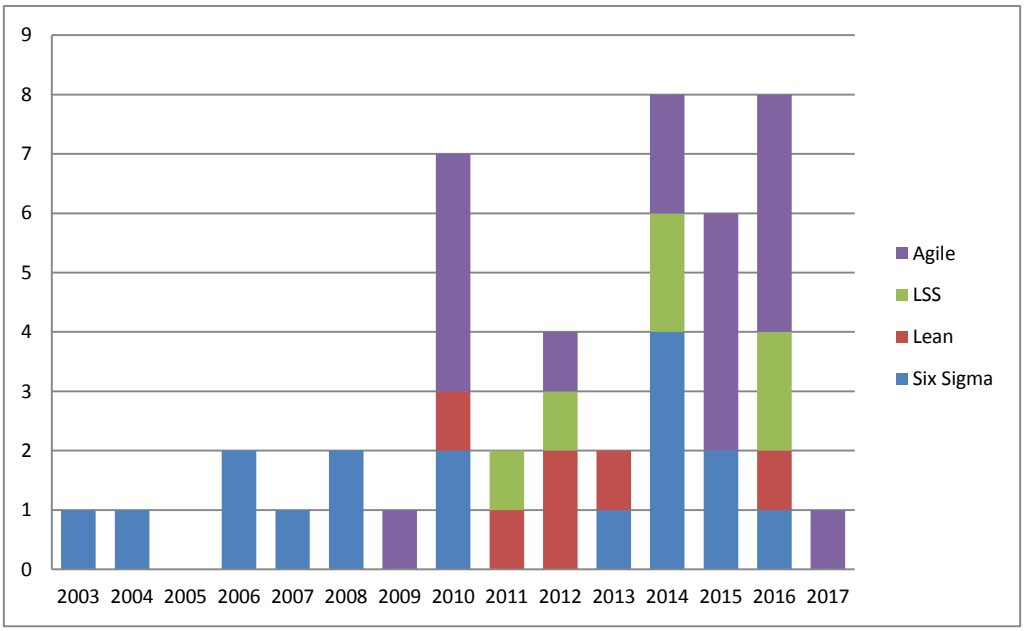

Fig.2. Chronological distribution of the research papers

Fig (3), Indicates that the applied computer and software engineering journals such as the Journal of Computer Science, Computer Engineering, Computer Technology Journal, Engineering Research, Engineering Material, and dominate scholarly publications on Six Sigma and Agile, While less dominant magazines were in the management and lean thinking area.

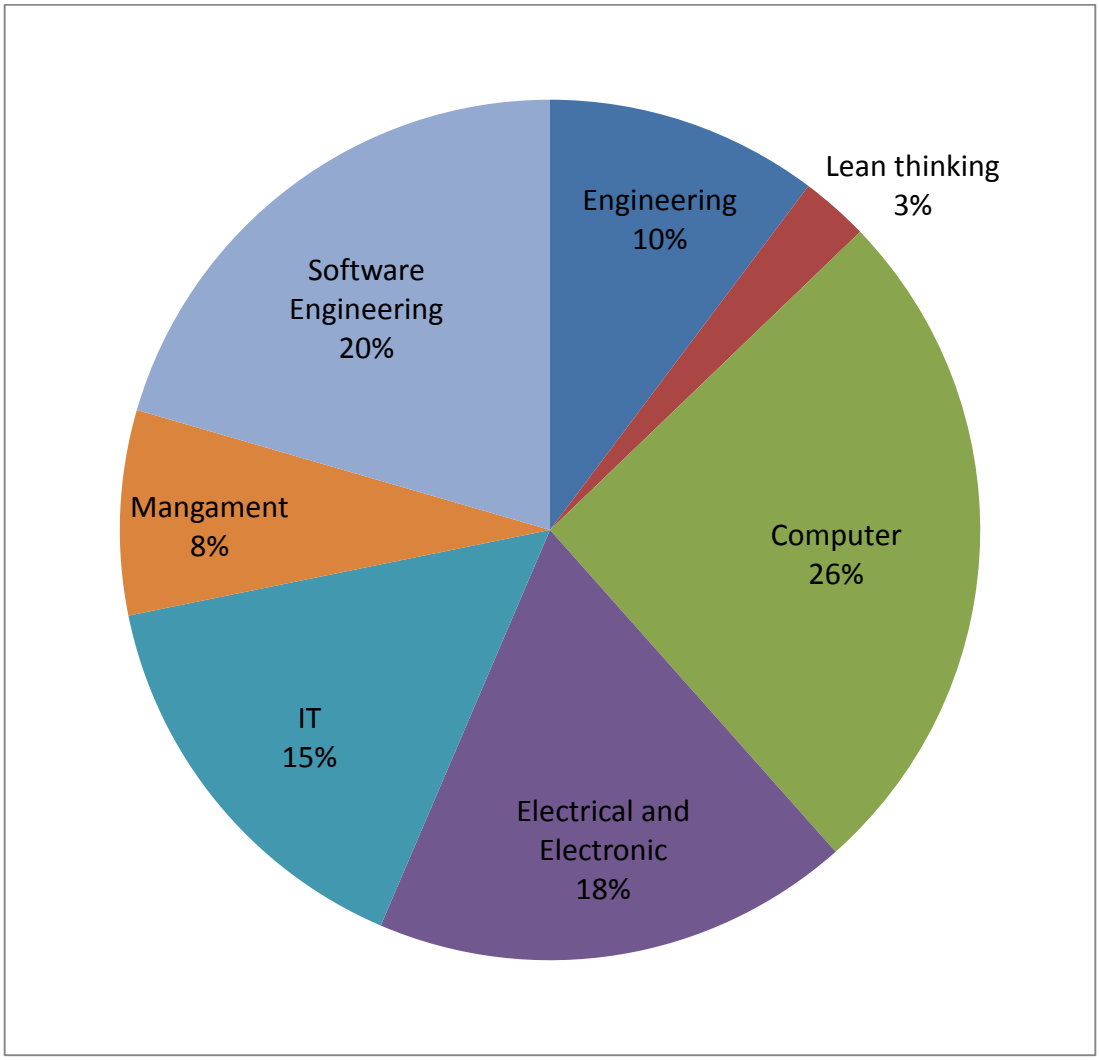

Fig.3. Distributed of journal sponsored by different societies of area

III. II Compare between methodologies

There is a fine line of difference between Six Sigma, Lean, Lean Six Sigma and Agile which has been indicated in the Table II.

Table II. Basis for comparison in methodologies

methodology	Six Sigma	Lean	Lean Six Sigma	Agile
Propounded in	1980	1990	1986	1990but applied it in early 2001
Definition	Six Sigma is a sorted out and deliberate strategy for vital process change and new item and administration advancement	Lean approach concentrates on examination and disposing of seven wastes on all through the entire procedure	Lean Six Sigma is an administrative approach that consolidates Six Sigma techniques and apparatuses and the lean assembling	It is a gathering of programming advancement techniques that advance versatile arranging, transformative advancement and conveyance, consistent change, and a period boxed timeframe to finish an assemblage of work.
Aim	To satisfy the customer requirements	To enhance creation by expanding productivity all the while	Less defects and decrease costs	Reduce overheads in the software process
Focus	continuous improvement,	Flow	performance improvement	rapid development
Theme	Removal variability	Waste removal	Improves Efficiency and Effectiveness	Prioritization technique
Tools	statistical measure of variability	Based on visuals	Statistical and non statistical tools	iterative, incremental practices

Six Sigma and Lean systems have a comparative target: they both mean to expel waste and make the most capable structure possible. Be that as it may, they receive assorted methodologies in the way this goal is to be accomplished. In least demanding terms, the essential differentiation amongst Lean and Six Sigma is that they perceive the fundamental driver of waste in an unforeseen way.

Lean experts attest that waste begins from trivial walks in the creation methodology that don't upgrade the finished thing, while Six Sigma advocates certify that waste is a result of assortment inside the procedure itself. Clearly, there is truth in both of these assessments, which is the cause both Lean and Six Sigma frameworks have been so viable in improving general business execution in various fields. In all actuality, these two requests have ended up being especially productive when working in combine, from now on the making of Lean Six Sigma. Agile offers, along with Lean, an incentive by decreasing the amount of waste. In some ways, Lean and Agile can be basically a similar concept. Also, Agile and Six Sigma take after a similar Approach; yet, there exist numerous contrasts between the two which speaks to a striking difference. The two approaches can be incorporated with each other in specific undertakings as well; however, by and large professionals lean toward utilizing both strategies.

Applying Six Sigma in a procedure, one can enhance process capacity by decreasing the variations (controlled) simultaneously. In software development process, process variations cannot be entirely eliminated, but effort has to be made in the meantime to realize incremental advancement by empowering quick and adaptable reaction to such changes. In this respect, Lean Six Sigma has a considerably more extensive degree and can be connected to any space of the industry; whereas, Agile has a limited scope and is particularly conceptualized for software development.

IV. CONCLUSION

From papers we reviewed, it detected that Six Sigma, lean, Lean Six Sigma and Agile methodologies in spite of the current prominence of these strategies in software development, little appears to have been done in promoting them, either in research or actual application. More specifically, each has to be improved significantly to ensure the validity of the findings and demonstrate sustainability. In addition, changes in organizational culture need to be studied as well as strategies to stay on course with other competitors and guarantee further transformation.

Six sigma and lean only a handful of magazines and newspapers provide most of the articles posted on this topic. These contributions are also limited to only a few investigations; almost two decades after its introduction, it is being successfully and continually used in manufacturing. Now it has spread too many other fields all over the world; yet one cannot claim that Six Sigma is thoroughly and commonly applied in software development everywhere. Software Six Sigma accelerates the test and joining parts of product improvement and submission of a good quality product to clients. It additionally enhances the consistency and repeatability of the improvement procedure.

The success of Lean Six Sigma in the field of software development depends on the outcome of projects. Little intent is observed as to explain differences in strategies and failures of any initiatives to apply them, if any. It is necessary to develop a framework to build a theory of why and how Lean Six Sigma works in Agile software development. There are a number of obstacles to Six Sigma use in this process, namely:

- Projects are not necessarily helpful or indispensable parts of formative critical thinking
- Training and accreditation can be an extensive and tedious process.
- Poor sponsorship opportunities and complex designation of duties leads to failure in item advancement and harnessing different process change viewpoints;
- Software is inalienably unique, and as such developer generally tend to tackle and understand each issue separately; and standard forms do not completely identify with the procedure of software development.

In software industry, Agile gives enhanced time-to-market, high joint effort and consumer loyalty. Six Sigma gives better process controls, higher proficiency and

adequacy. Applying Six Sigma approaches in Agile software methodology giving the most elevated quality items and administrations with minimal cost, while encouraging an effortless, quick improvement.

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