INTEGRATING LEAN SIX SIGMA WITH AGILE SOFTWARE DEVELOPMENT METHODOLOGY

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I certify that this thesis satisfies all the requirements as a thesis for the degree of **Doctor of Philosophy in Modeling and Design of Engineering Systems, Atılım University**.

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This is to certify that we have read the thesis "INTEGRATING LEAN SIX SIGMA WITH AGILE SOFTWARE DEVELOPMENT METHODOLOGY" submitted by "SAFIA KHALIFA BADWE" and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.

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ABSTRACT

INTEGRATING LEAN SIX SIGMA WITH AGILE SOFTWARE DEVELOPMENT METHODOLOGY

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In the last two decades, the Six Sigma approach has also experienced extended introduction into the software development industry, with lean thinking emerging as a new paradigm to make the process more efficient. Some software companies have been trying to adapt Six Sigma and Lean for their business and development initiatives. Lean Six Sigma (LSS) accelerates the test and reconciliation aspects of item advancement and makes room for providing top-notch products to purchasers. Still, a need for constant change and transformation has forced organizations into adopting to complex and new working environments, resulting in software development methodologies to become a framework for planning and coordinating programs and communicating with customers so as to collect the requirements. In this respect, LSS and Agile methodologies are regarded as a set of development initiatives to satisfy such demands at an early stage and incorporate high-quality changes into the software development process; hence the present study explores the relationship between the methodologies mentioned above in software development.

This research presents the results from a theoretical and empirical part. The first part is to introduce a model that combines the operational stages to examine Six Sigma, Lean, Lean Six Sigma, Agile and Scrum methodologies to try and devise a new approach called ‘LSS-Agile’ methodology.

The second part presents the results of a survey study conducted with practitioners of software development companies in Turkey and abroad. The questionnaire

focuses on several aspects, most importantly: benefits implementation, critical success factors, satisfaction, change requirements, experiences, and problems faced when using methodologies. The empirical perspective is analyzed by developing hypotheses about the concepts and factors on the study of methodologies and their impact on software development.

The results highlight the most important factors leading to the success and failure of software development as well as the most beneficial aspects of the performance of methodologies. To this end, the analysis of the Lean Six Sigma and Agile methodology, their interrelationships helps to better understand the idea of integrating the two. As a comparisons carried out between a number of Turkish and Canadian companies specializing in this field, the results confirm that Turkish companies in the software development sector entered the world market from the widest successfully and have become one of the most competitive countries in this field.

Keywords: Six Sigma, Lean, Lean Six Sigma, Software Development, Agile.

ÖZ

YALIN ALTI SIGMA, ÇEVIK YAZILIM GELIŞTIRME METODOLOJISI ILE ENTEGRE ETMEK

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Son yirmi yıl içinde, uslubu daha verimli hale getirmek için yeni bir paradigma olarak ortaya çıkan yalın düşünceyle, Altı Sigma yaklaşımı da yazılım geliştirme sektörüne uzun bir giriş yaşadı. Bazı yazılım şirketleri, iş ve geliştirme girişimleri için Altı Sigma'yı ve Yalını uyarlamaya çalışıyorlardı. Yalın Altı Sigma (YAS), madde ilerlemesinin test ve uzlaşma yönlerini hızlandırır ve alıcılara birinci sınıf ürünler sunmak için alan sağlar.Yine de, sürekli bir değişim ve dönüşüm ihtiyacı kurumları karmaşık ve yeni çalışma ortamlarını benimsemeye zorladı.Bu durum programların planlanması koordine edilmesi ve müşterileriyle iletişim kurmak için gereksinimleri geliştirmek üzere için yazılım geliştirme metodolojilerine yönlendirdi. Bu bağlamda, YAS ve Çevik yazılım metodolojileri talepleri erken bir aşamada karşılamak ve yazılım geliştirme sürecine yüksek kalitede değişiklikleri dâhil etmek için bir dizi geliştirme girişimi olarak kabul edilmektedir. Bu nedenle mevcut çalışma, yazılım geliştirmede yukarıda bahsedilen metodolojiler arasındaki ilişkiyi araştırmaktadır.

Bu tez çalışmsında teorik ve deneysel çalışmalardan elde edilen sonuçlar sunulmuştur.İlk kısım, “YAS-Çevik Metodolojisi” adlı yeni bir yaklaşımı denemek ve uygulamak için Altı Sigma, Yalın, Yalın Altı Sigma, Çevik ve Scrum Metodolojilerini incelemek için operasyonel aşamayı birleştiren bir model sunmaktadır. İkinci bölüm ise, yazılım geliştirme şirketleri üzerinde Türkiye'de ve

yurtdışında yapılan anket çalışmasının sonuçlarını sunmaktadır.Anket, birkaç önemli konular üzerinde durmaktadır. Bunların en önemlileri: faydaların olması, kritik başarı faktörleri, memnuniyet, değişim ihtiyaçları tecrübeler ve metodolojiyi uygularken karşılaşılan sorunlar. Ampirik bakış açısı, metodolojileri inceleyen kavramlar, faktörler ve bunların yazılım geliştirme üzerindeki etkileri hakkında hipotezler geliştirilerek analiz edilmektedir. Sonuçlar, yazılım geliştirmenin başarısına ve başarısızlığına ve metodolojilerin performansınınen faydalı yönlerine yol açan en önemli faktörleri vurgulamaktadır.Bu amaçla YAS ve Çevik metodolojilerininve bunların birbirleri arasındaki ilişkinin bu metodolojilerin birleştirme fikrinin anlaşılmasını kolaylaştıracaktır. Bu alanda uzmanlaşmış bir dizi Türk ve Kanadalı şirket arasında karşılaşmalar yapılmıştır.Sonuçlar, yazılım geliştirme sektöründeki Türk firmalarının dünya pazarına en geniş çapta ulaştığını ve bu alandaki en rekabetçi ülkelerden biri haline geldiğini göstermektedir.

Anahtar Kelimeler: Altı Sigma, Yalın, Yalın Altı Sigma, Yazılım Geliştirme, Çevik.

DEDICATION

I dedicate this thesis to:

The memory of my father, Khalifa

My mother, Allah saves her

My Husband and My dear children

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Abbreviations	
SS	Six Sigma
LSS	Lean Six Sigma
DMAIC	Define, Measure, Analysis, Improve, Control
DMADV	Define, Measure, Analyze, Design and Verify
DFSS	Design for Six Sigma
BB	Black Belt
GB	Green Belt
SDM	Software Development Methodology
CSFs	Critical Success Factors
SIPOC	Suppliers, Input, Process, Output, Customers
SDLC	Software Development Life Cycle
TSDM	Traditional Software Development
PM	Prototype Model
ASDM	Agile Software Development Methodologies
ASD	Agile Software Development
XP	Extreme Programming Methodology
RAD	Rapid Application Development
FDD	Feature-Driven Development
LSD	Lean Software Development
FA	Factor Analysis
H0	The null Hypothesis
ANOVA	Analysis of Variance
SPSS	Statistical Packageforthe Social Scienc

CHAPTER 1

INTRODUCTION

Today, the software industry is one of the most advanced and fast-moving sectors in just about any economy around the world. Companies must move aggressively to stay ahead of the progress and competition. Managers and heads of departments are exposed to pressure while executing projects, especially when it comes to software development projects. This competitive field requires people with skills and experience in the industry mainly due to the fact that there are constant changes taking place in technology.

Project management is a set of administrative activities in the implementation of software projects involving expertise, techniques and tools to be employed; in other words, a host of planning, scheduling, performance determination, negotiation and communication.

As a result of the ever-changing needs and the convergence of requirements and expectations in software development, achieving quality in this field is not easy because it is a set of features and characteristics coming together to meet the requirements of customers. As software development methodologies aim to deliver error-free products, new methodologies are to be used to help manage their projects and, in this way, give them advantages, unlike previous and traditional methodologies that did not quite do so.

1.1 Research Background

The rapid expansion of information and communication technologies in all fields of business creates pressure to maximize the efficiency of operations in software development processes. More than ever, the relationship between quality, cost, and delivery time has become a crucial condition for success, and developing software products at competitive costs that meet high-quality standards and in accordance with tight, even same-day, deadlines has become a daunting task. In addition, the

process is at times limited due to strict documented procedures that call for, yet again, strict monitoring mechanisms, creating a need for additional development operations in project management software [1].

In response to this, a new family of software development methodologies has been introduced, offering Agile methodologies to meet the difficulties of future developments in the software industry. These strategies center around adaptability and versatility, and are even depicted as elegant in contrast to more clumsy, traditional processes [2]. Software development is one of the most complex tasks performed by humans and has become increasingly challenging, especially in recent years as the size and complexity of software systems has grown, making it harder to coordinate the work of multiple developers [3]. 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 light of such developments, 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. From methodologies that have advanced quality standards and are effective in improving the cost and growth of (Lean, Six Sigma, Agile, Scrum, Extreme Programming, Adaptive Software) software development projects that have not been widely adopted except in recent times.

1.1.1 Lean

The Lean approach concentrates on the examination and disposing of seven areas of waste-creation all through the entire procedure. In addition, it helps with non-stop streaming and smooth operations in each branch of the plant, for example, outlining divisions, obtaining or creating offices, conveyance maintenance, and administration and ensure correspondence between the developers and clients [4]. The primary goal is to prioritize the will of the client and reduce waste through making use of scarce assets resources. A Lean organization profoundly values its customers and their choices and makes them its own concern to be achieved on a continuing basis [5; 6]

1.1.2 Six Sigma

Six Sigma is a business philosophy concentrating on continuous perfection [7]. Means of utilizing a group of different statistical instruments to form methodical devices to guarantee flawlessness in the item produced and, ultimately, ensuring customer satisfaction [4].

The term “Six Sigma” refers to a methodology offered to enhance the efficiency of improvement operations in companies intending to make a profit by means of quality services. In other words, it is the process regarded as essential for any development efforts. For this, a process is divided into a product process or service process either from that the company offers its customers from the outside or it cans the company inside or for instance, a billing process or a production process. In Six Sigma, the main objective of the process of optimization is to enhance effectiveness and, at the same time, reduce the contrast that might occur in performance. Consequently, this results in diminishing the inequities and growing the profits and staff standards, which ultimately causes businesses to reach a state of excellence [8].

1.1.3 Agile

Agile software development techniques are one of the principal methodologies used in software development. The word ‘agile’ means to be fast and light, implying freedom of movement and a state of alertness. The Agile is used to describe practical concepts that differ substantially from current and conventional process models [9]. The concept of Agile software development was first coined by Kent Beck, who pointed out that Agile software development is a superior way to build software and to help others build everything at once [10].

The interactions in software development processes as well as the teams of experts are regarded as more important than either the process or the tools employed, and work schedules are more important than complete documentation; collaboration with clients is more important than negotiating contracts; and being sensitive is more important than any changes in the root of the plant.

However, when used as a model for other processes, Agile software development has its own disadvantages, too, and is not necessarily suitable for all types of projects, products, and people’s attitudes. It allows for an Agile-fashioned

development process, and is tolerant of changes in requirements as it is able to more rapidly respond to these changes.

1.1.4 Scrum

A Scrum framework is part of the Agile methodology, which is expected to increase flexibility and speed in the development of a software project. Further implementation of a thorough study of the maintenance and support of the product being launched could add to current practices in the crowded software market [11]. Scrum sets high-repeat organization practices remembering the ultimate objective to track consistent issues and project development. Scrum is generally embraced in companies which have not made progress by traditional method and it is too usually consolidated to other methodologies [2].

In software development processes, variations cannot be entirely eliminated and effort has to be made 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.

1.2 Aim and Objectives of the Study

The literature includes a lot of Agile rating papers in a variety of software development and a few works in Six Sigma and Lean. The major goal of this study is to improve software development by integrating Lean Six Sigma and Agile methodology, and to form a new planning template, which combines the stages of the implementation of the two methodologies based on previous studies presented in this framework. A survey in the form of a questionnaire will identify the most important concepts and factors in which the two methodologies agree, and will evaluate each of them separately.

In short, the main objectives to be achieved in the present paper are as follows:

- ✓ Embracing this methodology enables the organization to better identify and meet customer by accentuating on inventive critical thinking aptitudes and cooperation.

- ✓ This integrated approachcan also be useful in a non-manufacturing context, such as the software sector.
- ✓ Eliminating waste lessens costs, as well as results in quicker business procedures and more fast client reaction, additionally expanding income development.
- ✓ Integration improves the execution speed of process initiatives.
- ✓ Integration also supports incremental improvements designed with the delivery of an iterative process.

1.3 Sub-problems and Related Research Questions

- ✓ What is the relationship between success factors for companies that use Lean Six Sigma and the success factors of companies that use the Agile?
- ✓ What are the similarities and differences between the barriers facing the implementations lean Six Sigma methodology and Agile methodologies in software development companies?
- ✓ What are the similarities and differences between the benefits the implementations Lean six sigma methodology and Agile methodology in software development companies?
- ✓ How does the implementation of Lean Six Sigma contribute to software methodologies?
- ✓ What classifications and principles can be employed to fill the gap between the two study methodologies ?
- ✓ How can we develop a blended model of Lean Six Sigma and Agile?
- ✓ What are the challenges during Lean Six Sigma implementation with Scrum?

1.4 Thesis Structure

The thesis is divided to seven chapters designed as shown in Figure1.1.

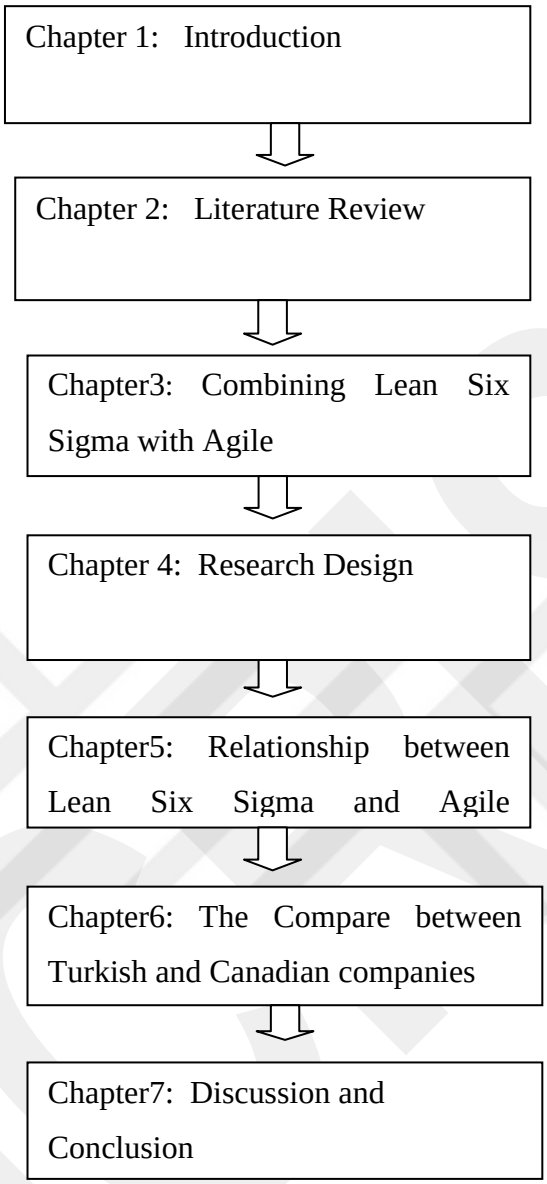

Figure 1.1 Thesis structure

Chapter 2: Literature Review

The review shows the trends ongoing and deals with of Six Sigma, Lean, and Lean Six Sigma in the manufactring and software development.The discussion is also on software development methodologies and Agile methods in addition to other related workson the topic.

Chapter 3: Combining Lean Six Sigma with Agile

This chapter presents details about the stages of Agile and Six Sigma implementation and explains the possibility of integrating tools and concepts for Agile with Lean Six Sigma and building a new model that embodies both.

Chapter 4: Research Design

This chapter contains a presentation on the methodology, research strategy and how to collect data, as well as details about the development of the instrument and analysis some hypotheses of methodologies.

Chapter 5: Relationship between Lean Six Sigma and Agile Methodology

In this chapter, data analysis results are shown regarding the survey using the SPSS statistical program.

Chapter6: **The Compare between Turkish Companies and Canadian Companies in Some Concepts Respect to Lean Six Sigma and Agile Methodology**

In this chapter, data analysis results are shown regarding the survey between Turkish and Canadian companies about using LSS and Agile methodologies.

Chapter 7: Discussion and Conclusion

In this chapter, discuss the results obtained in analyzing the research data and present a summary of the most important results obtained.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The aim of the literature review is to provide profound understanding of the study and related outcomes. In other words, the emphasis of such review will be on the studies that have been carried out on the field of Six Sigma, Lean and software development, its primary progresses and to detect the uncovered gaps which require additional investigation. The evolution of Six Sigma and its advancement shall be contained in this chapter briefly. Given the fact that the antiquity of six sigma is relatively short paralleled to software improvement, the existing writings dealing with the "know how" of Six Sigma are diminutive. Moreover, numerous studies endeavored to utilize the knowledge and achievements of pioneering firms stating aspects considered to be precarious in instigating Six Sigma.

In the current study, previous knowledge and understanding on the subject of software development have been utilized to build upon and have been benefited from in order to provide profound insight into the elements which might be responsible for the changeability in Lean Six Sigma performances and Agile methodologies. Furthermore, an outline has been given regarding Lean, Six Sigma (SS) and the approaches of Lean Six Sigma (LSS), Lean Six Sigma remunerations, precarious issues for the success of Lean Six Sigma applications, and the confronted defies in the course of LSS implementations in software expansion. Also, descriptions of software development and principles have been given as well as methods used.

2.2 Definition of Lean

Lean is 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 [5].

Consequently, the crucial aim here is the creation and delivery of the finest customer values by means of a process designed for such purpose having a zero remains. In order to achieve such goals, rational based lean is nowadays focusing on the side of improving self-governing expertise management, dynamic and vertical divisions aiming at enhancing the goods stream and services throughout the chain of values. However, the means for accomplishing such goals are technologies, assets, and high quality services introduced to customers.

The dismissal of waste is usually carried out through value streaming instead of separated topic making it a course that necessitates less human involvement and pains. In addition, less room, less assets and less time are needed for the production of products and services with diminutive number of imperfections. Nowadays, the rapid variation in customer requirements is met by a quick and appropriate response from cooperation's of both very high quality and low cost features. Furthermore, the simplicity and accuracy of applying information management need not be emphasized [5; 6].

For the improvement of businesses in marketplace that is motivated by very high competition by eliminating waste and improving operations, lean has demonstrated to be an effective management philosophy [12]. The lean's first execution was chronicled in Ford factories in the year 1913. Lean has is defined by both Womack and Jones as follows:

"A means for identifying value, categorizing value-creating activities in the best possible order, is carrying out such activities in an unceasing style every time somebody asks for them, and establish them in an active style. Briefly, the reason lean philosophy is as such is that it offers a method for establishing more with less human exertions, less supply, less time and less space, while residual very close to offering customers their needs and wishes [13].

2.2.1 Lean Manufacturing

In the industrial sector, the word (*muda* in Japanese) means waste, and has many formulas as for instance material form, unexploited potential, joblessness and inventory. Lean's mean 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 [14]. The value of the product 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 by extrication value added activity (VA) and non- value added activity (NVA).

Furthermore, transpiration, inventory, motion waiting, overproduction, over processing and defects are good examples of NVA actions [12; 15]. Many kinds of lean means are variable and can be utilized efficiently, such as like cellular manufacturing, continuous improvement, production smoothing, standardization of work, total productive maintenance (TPM), SMED, etc [16].Universally employed lead manufacturing practices are traction systems JIT / Kanban, SMED, manufacturing cells, 5S, Kaizen, total creative preservation, visual examinations, and the organization of work consistent work ways and line assessment [17].

2.2.2 Lean Implementation

Through the proper implementation of lean components, the faultless endeavor of the manufacturing system can be accomplished. The main stream reviews regarding lean components, deal fundamentally with merely one or two components or otherwise a group of two to three components [15]. The blow mentioned services are considered the furthermost significant outcomes from the execution of lean production:

Not as much of time, diminish inventory, lessen faults, and develop the ability for exploitation of resources, mend distribution amounts, greater than before yield, and decrease charges per unit [12]. It is worth mentioning that the implementation of lean process should not be undervalued as it is more than just altering one or two

rudiments of the system or the process or exchanging some sort of tools in the entire system. Visibly, it may not be an upsurge lean production conceivable to provide a genuine exertion and the extension of all stake holders in the organization: labor, management, suppliers and others. Such profound shift in the performance of the organization might be carried out by means of providing a guenon cultural revolution inside the organization. In addition, some kinds of deep change in the quality of the organization management and engineering have to be initiated and achieved. For Six Sigma projects and initiations, the true existence of strong management is one of the most crucial factors for the successful of the transformation pledge.

Nevertheless, every single firm is required to tailor the application recipe in order to suit the lean tools due to the fact that no general formula for lean implementation is given. Generally, every single subdivision has their own perception, contrivances and limitations for exploiting and utilizing lean practices [14; 17]

2.2.3 Lean Elements

Employment of lean industrialized scheme, there are some chief essentials, which are acknowledged by the revolutionary scientists such as value stream mapping (VSM) that describes this term as "are Value Stream Mapping (VSM**)** which describes value stream as "every single action comprising Value-Added activity (VA) and Non-Value-Added activity (NVA) essential to change the raw material into manufactured goods by means of planning of process and data streams crucial to every product" Push and Pull System which defines, the Pull system depend on client obligation while push system count on prearranged program [15; 18].

2.2.3.1Value Stream Mapping

This is a frequently functional instrument within lean, and it is nothing but a chart analysis tool [19]. The manufacturing of lean usually concentrates on the streaming of value and practices of lean preparation employment. Consequently, lean is essentially the employment of assimilation VSM of the value chain in the VSM procedure as a fundamental means for the scheme improvement. In LSS lean setting, VSM is a serious primary stage in altering lean terms are utilized VSM as a

communiqué means and as a business scheduling tool for the change management on the way to the emergence of lean environment. In addition, VSM assists many trade associates to recognize waste in their schemes and determine the waste's sources with the value chain process [17].

The virtuous appreciative of the lean conceptions and practices has led to the development of VSM, which is concerned with the value related to the customers desires and needs. This is similar to the process of recognition related to the DMAIC approach. In addition, it stresses the harmonizing association between of Lean manufacturing and Six Sigma. It is an established datum, that both DMAIC and VSM practices are matching each other, which encourages the utilization of both methods [20]. Customer fulfillment often demands the delivery of whole hearted actions such as on time delivery, low prices, features and functionality and product quality [14; 17].

In the VSM system, the ease of obtaining data simplifies and authorizes the verdict for implementing lean tools. Also, it can inspire the firm or organization in the course of tangible execution for the sake of attaining the anticipated outcomes. VSM obviously designate the inventory, process time, lead time, waiting time, and course movement based on which one can deal with blockage cycle time against Takt time [15].

2.3 Six Sigma

The term "Six Sigma 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. Moreover, it is an established fact that six sigma is the fastest growing management scheme in the sector of commerce nowadays due to the fact that it has proven to have saved billions of dollars for many business since 1990s.

This sachem has been only recognized after Jack Welch, even though it was established by Motorola in the mid-1980s, and GE makes it the central them for his work in 1995 [8]. A sigma level is employed in order to determine a company's efficiency and productivity level. Despite the datum that these practices have dealt with between 6,200 and 67,000 problems per million opportunities, companies accepted three or four sigma performance levels as the norm [21].

The term "Six Sigma" is have been known to be deduced from the arithmetical term "Sigma"(δ) which means the standard deviance or deviation the term "Six Sigma Level" in the production process would imply that the process imperfect degree is 3.4 defects per million units. Therefore, it is apparent that the term six sigma denotes some level of reliability. From practical point of view, the main objective of Six Sigma is to minimize the in consistency in order to attain very small non conformities. The fundamental difference between Six Sigma and other processes utilized for the same purpose is that Six Sigma is implemented in a wider manner which includes all features of businesses aiming at enhancing fundamental processes. For instance, it assists in crafting a decent scheme, extraordinary level of dependability, reliable clients billing system, and project management system [8; 21].

2.3.1 The Statistical Representation of Six Sigma

It is a recognized fact that the term Six Sigma has been deduced from the sector of statistical quality. Formerly, it denotes the competence of a process in manufacturing a high amount of production operations according to given specifications. Processes that utilize Six Sigma qualities within a short term for producing long term defect degrees below 3.4 defects per million opportunities (DPMO). The main obvious target of Six Sigma is improving all processes but not essentially to the level of 3.4 DPMO. It is imperative for companies and organizations to specify their level of sigma which is appropriate for their processes and try to accomplish it. Consequently, the duty of determining and specifying zones that require development lies on the management shoulders [8; 22].

2.3.2 Methodologies

These methodologies or approaches consist of five stages and each of them is with DMAIC and DMADV stands maintaining the view point that “its 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" [23]. Clearly, all Six Sigma tasks are [24] down:

• DMAIC is utilized for schemes intended for enhancing present business processes, the stages are described in the following Table 2.1.

• DMADV is employed for schemes intended for generating innovative product or process scheme.

Table 2.1 DMAIC steps

Step	**Y=f(X)**	**Explanation**
Define	Identify Y	Classify and select most dire business issues and apprehensions
Measure	Characterize Y and identify X’s	Classify and gather the fitting statistics which are related to the flaws and the processes need upgrading.
Analysis	Translate Y into X’s	Explore the statistics gathered in preceding stage to realize the source reasons of the flaws and poor performance.
Improve	Optimize X	Pinpoint substitute resolutions and approaches established on the data resulting from analyze step.
Control	Manage X and monitor Y	To guarantee that predictable enhancement has been attained, and the data and involvements have been recognized and shared to endure at achieved high degree efficiency.

2.4 Introduction of Lean Six Sigma

Recently, a practice or a method called Lean Six Sigma has come to existence as a result of the merging of all Six Sigma concepts with lean manufacturing by some experts. SS together with Lean manufacturing, which deals with process streaming and waste concerns, is concerned with dissimilarity and design and harmonizing corrections intended for boosting business and operational effectiveness [25].

(George) concept of Six Sigma and provided a definition foe 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". Firms such as (USA company) GE, Verizon, Jeenba kt and IBM have been utilizing LSS to better incorporate change in both skills and development aspects. LSS has been considered and recognized as the innovation regarding industrial improvement, increased growth in projects, and better software to be provided.

2.4.1 Definition

Lean Six Sigma is motivated by the notion of development in such a way to inhibit flaws; it focuses on fulfilling the demands of customers and providing ideal end-products by reducing deviations, waste and cycle time and, at the same time, encouraging cooperative working and streaming. The approach can apply anywhere waste may occur and can be applied by any individual involved. Clear boarders between Six Sigma and Lean have been determined; expressions such as "Lean Six Sigma" are heard quite often and about. In this respect, to advance the process necessitates features of both methods to make sure that optimum results can be gained [26; 27].

Such incorporation of the approaches is essential for the reason that Lean by itself cannot have an arithmetical governing process; on the other hand, SS is unable to single-handedly achieve the desired outcomes in terms of speed or cost effectiveness. Together, nevertheless, they can deal with the issues of quality and costs more effectively than any other improvement strategies [28].

2.4.2 LSS Principles

For the sake of gaining increased shares of customers and market, numerous establishments are applying LSS codes to boost functioning and reduce waste through the most operative solutions to the issues at hand. The program is made to deliver the desired results for practicing these principles aimed at improving businesses and growing career skills [29]. In what follows, we introduce the six principles of LSS:

1) All outcomes are verified by data with a certain degree of doubt.

2) For enhancing competence, one is required to focus on their admission, excision and control.

3) The variance bootees reliable competence. The LSS expert should fix irregularities and eliminate them wherever conceivable.

4) Development can only be attained through suitable measurements and statistics.

5) Only a few vital contributions can have a noteworthy influence on manufacturing. Concentrating on the intricate matters can be decisive.

6) Each decision may contain an element of uncertainty and, hence, ought to be always and wisely premeditated, bearing in mind the consequences.

2.4.3 Comparing Six Sigma and Lean

A team is required for the implementation of Six Sigma and Lean manufacturing. SS team is usually assigned for Six Sigma projects and Kaizen teams are normally appointed for lean manufacturing. Teams dealing with such projects have to work under the supervision of specialists and experts such as for instance master belts or Lean consulting specialist [30]. Lean systems and Six Sigma are normally aiming at working for achieving the same goals, which is eradicating waste and generating more competent system, we can see that in Table 2.2.

Table 2.2 LSS expose alike problems [18].

Lean	**Six Sigma**
Absence of customer attention Deficiency of staff authorization Messy, wasteful work places Suboptimal maintenance practices Shortage of cross-training Additional inventory Dearth of noticeable controls	Absence of customer Emphasis in sufficient measurement systems Suboptimal processes Imperfection chances Out-of-date processes and metrics Dearth of ownership of processes

The furthermost precarious variance between Six Sigma and Lean is the nature of people participation. To support Six Sigma under taking exhaustive engagement of development experts are qualified and hosted into a Six Sigma administration organization with numerous protagonist designations often referred to as Black Belts, Master Black Belts, Green Belts and Project Champions [31].

Table 2.3 Abridges the variances between the two structer as shown in the applied problem resolving [32].

Lean	**Six Sigma**
Go and See	Gather information
Decent enough statistics	Exhaustive usage of authorized statistics
Graphical information exhibition	Stylish and arithmetical scrutiny
Shop floor driven	Expert driven
Regular Kaizen	Scheme concentration
Value stream emphasis	Process emphasis
Accomplishment bias	Examination bias

Here owing to dipping dissimilarity, refining procedure, zero defects. Lean manufacturing emphases on eradicating waste and refining streaming in manufacturing, while Six Sigma emphases on removing flaws but does not clarify the perfection of the problem and how to advance course movement. Lean trade does not elucidate arithmetical tools to demonstrate outcomes, which were attained through Six Sigma [30].

Table 2.4 abridges the variances concerning the aim of each approach, tools, application drivers, talents gains, method, procedures, emphasis, and viewpoint [14; 33]. In Table 2.4 we can see comparison between Six Sigma and Lean.

Table 2.4. Comparison between SS and Lean.

variances	**SS**	**Lean**
Objective	To progress process competence and decrease dissimilarity in process waste	To decrease lead time and process waste
Emphasis	Process aftermaths	Process flow and waste
Attitude	Changeability within stipulations is cost Arithmetical evaluates	Time in system and congestion is cost
Tools	Statistical analyses	Workshop behavior
Usage	Production and business processes	Production and business processes
Method	DMAIC problem-solving	Value stream planning and lean procedures
Major measure	DPMO	Lead time
Main driver	CTQs/CTSs	Value-added
Project selection	Problem solving	Continuous improvement
Expertise	Principally logical	Chiefly process familiarity

2.4.4 The Approach

There are various works as regards the tools and methods employed in Six Sigma. As for the tools, they are typically referred to in very restricted ways and inexplicitly, while the methods enjoy broader referencing and target precise aspects such as abilities, vision, and preparation. Through the use of LSS as a practice, the purpose is to obtain continuous growth with emphasis on detailed decisions and discovering the sources of problems [34].

Lean Six Sigma project achievement is guaranteed as it associates practical problem resolving approaches and tools, and project running methods to implement, with the approval by the entire individuals who are exaggerated or will be exaggerated by the resolution. The further most of Lean Six Sigma tools are the identical to the mutual excellence tools [34].

Table 2.5. Emerging innovative and product with LSS [34].

DMAIC	**DMADV/ DFSS**
Removal of undesirable features	Cohort of affirmative features
• Feature: lessen imperfections • Rapidity: increase speed • Prices: reduce costs	• Problem-solving • Generating opportunities • Look noble • Feel decent

Both methods add to each other through working within the LSS. The DMAIC project began either in numerous forms in the cycle or in revised form to promote (DMADV/DFSS) Lean projects [12; 14]. In the SS domain there are numerous practical capability stages, the numbers of stages as well as the stages designations vary depending on the basis [35]. Presented five know-how stages as shown below:

- Blue Belt
- Yellow Belt
- Green Belt
- Black Belt
- Master Black Belt

These five stages vary from each other regarding training necessities. Blue Belts are trained with fundamentals. Yellow Belts are skilled to contribute in Six Sigma tasks

as associates of the squad. Green Belts have accomplished Six Sigma exercise and can lead minor Six Sigma schemes, typically Green Belts work as part time task directors. Black Belts dealt with unconventional Six Sigma training and functioned as full time project directors. Master Black Belts enjoy furthermore widespread knowledge and they are talented of educating the Six Sigma approach [34; 35].

2.4.5 Critical Success Factors (CSFs)

CSFs are thought to be amongst the furthermost and noteworthy aspects of excellence in supervising structural goals and purposes as well as operation process. CSFs are the elementary factors essential to be attained by the corporation or the areas that yield the utmost "inexpensive influence". It is commonly acknowledged that the aspects vital to achievement are not goals, but the actions and processes that can be measured by administrative and supervisory standards and in accordance to the aims. It is paramount to classify all the pressing issues and plans in such a way as to make innovation and upgrading possible and maintain success over the long-run [17]. There is increasing focus on CSFs for applying Six Sigma, and the works deal with issues such as organizational substructures, administrative duties, corporate policy, ethnic diversity, training and human resources management, client effort, task administration, talents, task choice and urgency, understanding, and DMAIC methodology [36; 37].

Many universal CSFs of Six Sigma and Lean implementation have been noted previously, among which one may find the following: organizational undertakings and obligation, incentive and appreciation scheme, administrative philosophy, client focus, up keeping of team associates, everyday assessment of LSS/SS task outcomes, dealer association, title roles for data skills, concentration in media, achieving excellence in information and exploration, actual LSS teaching package, previous project achievement stories and finest practices

The overall main findings about LSS so far lead us to the notion that the top most significant issues are organizational pledge, social change, and bringing LSS in line with commercial plans and management styles. The results also show that the most essential aspects are connecting LSS to HR rewards and spreading it to supply chain [38].

2.4.6 LSS Benefits

As LSS merges the benefits of both LSS, it is able to deliver additional services when compared to using just one approach [13]. Though many researchers have offered conflicting reports as to LSS benefits, there is a broader recognition that it is a commercial process development practice able to deliver fundamental advantages.

- Progress functioning competence and usefulness [39].
- Increased processing and additional participation by clients [30].
- Added processing abilities through waste reduction and focusing on perfecting the product by reducing imperfections [40; 41].
- The Six Sigma procedures are changed from slow to fast by Lean. In turn, the productivity of Lean is increased by SS. Leans productivity also offers ideal and effortless flow for the structure [30].
- Smooth processing brings about customer satisfaction upon improved end results [13].
- In all, LSS and TQM practices are the solutions to materializing developments and maintain them [42].

The aim of this tactic is DFSS recession react to the requirements of each client and the corporation, which produces a diversity of welfares for all contribution in the progress procedure. We can see diversity of remnueration in LSS in Table 2.6.

Table 2.6. Diversity of remnueration in LSS [8; 12].

Substances	**Corporation**	**Worker/ Squad**
•Perceivable advantage(value) • Yields / processes and schemes in line with necessities •Dependable yields / processes and systems • Decent cost-benefit proportion	• Safety and threat minimization • Diminutive time-to-market •Provision and mending cost reduction • Border safety throughputs • Improved image • Repeatable successes	• Actual tools • Mutual semantic • Safety in every stage of the project (flow-up /flow-down) •Repeatable achievements •Loftier incentive

2.4.7 Who Benefits From Using LSS?

2.4.7.1 Small- and medium- sized trades

LSS works for small and medium enterprises (SMEs). Actually, in further most situations, the alike achievement that is attained inside enormous businesses could not be attained in insignificant and medium-sized initiatives and smaller can change quicker for the reason that less individuals, fewer supplies and inferior ranks of the administration and interested administrations. SMEs should emphasis on the obstructing issues to decrease the consequence on the LSS application. This wills assistance attains frequent excellence development, charge reduction, clients' gratification, and upsurge in transactions capacity and attainment targeted revenue [43]. The remunerations are not indefinite, and LSS improves incomes and decreases expensive method whereas releasing up capitals which can be utilized on the way to exertion organization demand to attain. For instance:

- Additional development schemes
- Growing
- A novel invention or facility

SMEs are faced up with burden from its opponents. Particularly huge businesses for the reason that they can deliver advanced value goods at the lesser charge associated to minor and moderate initiatives [44]. This work looks to classify the utilization of LSS through a trial in the case of small and medium enterprises the study of food delivery in the Kingdom of Saudi Arabia [45]. The goal of this task is to lessen the degree of scrap charges in the product the practice of “Remote Acceleration Sensor (RAS)” (LSS).

2.4.7.2 Building a Powerful Engine for Continuous Improvement.

LSS is a method that emphases on demanding outcomes enhanced data-driven procedure. It syndicates two organization practices acknowledged by the commerce established by businesses such as General Electric, Toyota, Motorola, Bank of America, as well as ourselves. Through assimilating procedures and tools LSS, we are generating a commanding dynamic power to advance the excellence, competence, and rapidity in every feature of our industry [46].

The submission of LSS for the utilization of incessant development, and advance administration, progress competence and upsurge significantly in the previous period, and appears to have developed the emphasis facto manufacturing [47]. The business applied LSS to decrease events that have no value though meeting security necessities and to share teachings educated from practice test theoretical perspective [47].

The finest procedure to safeguard in effect and extraordinary efficiency, dipping the waiting time to eliminate wreckage for examination of non-essential / transfer product over a functioning scheme, producing additional effective scheme operation, which is more steady and dependable [48]. A KLSS assistances categorization process is appreciated and necessities to achieve the crucial to meeting client prospects tasks [49]. The text is to prove the usage of LSS to recover the superiority of maintenance archives at the Ministry of Transportation of natural [50]. This commentary debates the usage of expertise to develop feature control in profitable, monetary and investment businesses, and facilities. One of the expertise's, which are utilized to assess hardware enactment trading, is the arithmetical process control (SPC) [42].

2.4.7.3 Services

A background pointed at refining the competence of service administrations must reflect the five crucial features of services: inseparability; inconsistency; expire capability and absence of possession [13]. It is improper to ruminate that a perfect established for the manufacturing zone can be realized and works in services and dissimilar in manufacturing, one of the chief subjects that ascend in services is when attempting to establish lean codes to imperceptible produces. There is absence of indication concerning the encouraging possessions of lean alteration on service administrations.

Different than production, services are dissimilar by nature and very frequently destined by time in terms of the procedures that cause the emergence of a consequence that assistance a client. In services administrations, lean originates as a practice to decrease waste in terms of time (cycle time, waiting times), capitals to

permit the process to be more effective. It necessitates the inspection of the process from the clients' viewpoint, so as to remove the waste and disorganization. SS, though, emphases on purifying the procedure to lessening consistency, mistakes (flaws) and advance dependability [13].

2.4.7.3.1 Financial Services

Still incomplete funds and capitals squeeze usual. LSS reduce the time to get novel clienteles, and decreases the interval to deliver client amenity and make income quicker [27]. Prominence of services has also improved since it has become an imperative basis of work [51]. Refining facilities of well-being carefulness in inexpensive manner and uphold an excellence of service is the chief goal of this research. The broad-spectrum well-being precaution services model benefit from notions of Lean and Six Sigma to advance a tactical model. Lean perception is to advance the life cycle process and remove the unwanted [40]. The appropriate data on the remunerations attained, to deal with the chief complications, and the core teachings extracted from the application of LSS, which is probable to be valuable for administrations desiring to monetary facilities in the submission of the same tool [40].

2.4.7.3.2 Healthcare

cumulative pressure on health services, Lean Six Sigma can aid to upsurge the quantity of time that care workers are talented to devote for patients, plummeting the time consumed in the Stock, and decrease the time individuals devote waiting for carefulness, or undecided rights waiting for a call [27]. To develop services of well-being care in a modest improvement and preserve excellence, of service is the foremost goal of this study. The application services general health care model concepts of Lean and Six Sigma to grow a planned model [46].

Defines the case of implementing the codes of LSS in a remedial city center for experts (VAMC) in the Midwestern United States to resolve the issue of the precise controlling excellence. Consequently, the consequences may not be generalizable to other administrations [52]. In this commentary, the fundamentals of Lean and Six

Sigma are offered and were prearranged a suggestion to smear the notions in the medical manufacturing, along with harmonization with the organization embodied by legitimate necessities decent industrial observes [53].

By means of Lean Six Sigma practices and upsurge competence or monetary enactment through the operating room. The newest development to be accepted incorporations around the domain recognized as the "LSS" Quality [54]. This commentary defines the scheme excellence development to decrease re-entry into medicinal precaution connected to the inhabitants of heart failure, severe myocardial infarction, and pneumonia happens [55].

2.4.7.3.3 Technology

As users progressively depend on the knowledge, Lean Six Sigma aids businesses Deliver yields with fewer flaws and inferior back and more [27]. Subsequently the execution of Lean Six Sigma in the highest large-scale teaching has not extended [56]. This text labels how Lean Six Sigma can be employed efficiently in the teaching of engineers. Merging this resolution as a means to device the protection of the development has been anticipated. The employment of the anticipated solution to upsurge the efficiency of one of the threads from 38% in 2009 to 71% in 2010. Finest repetition businesses utilizing Lean Six Sigma to pay for the information technology (IT) and software design enhancements for a superior year. None the less widespread approval, though the consequences verified in the area has been sluggish [57].

SS can lean toward the acquisition way, and procedures performed when there is an extensive use of expertise and infrastructures systems (ICT) information. It was a background and was applied to acquisitions, founded on the finest observes exploration and numerous applications [58]. Combined programs LSS in practice, rather than into the hypothetical foundation or founded motivationally disagreement. The drive of this work is the execution of combined application programs support services LSS and assess the paybacks of incessant development of services Information Technology Infrastructure Library (ITIL) [46].

2.4.7.4. Manufacturing

Managing a dynamic situation, coming about because of the presentation of new items and the expansion of market request which can cause diminishments in the level of value and efficiency. LSS improve venture performed in a production line of the organization's machining part, keeping in mind the end goal to take out misfortunes that cause low efficiency, influencing the satisfaction of the creation design and consumer loyalty [59].

The adjustment as a primary concern of the ventures is because of the raising interest from the client for a quality items or administrations requiring little to no effort with decreased lead time, assist it is free from abandons. These elements push the enterprises to center around their changes, to enhance the quality in manufacturing area by blend of Lean and Six Sigma. This task tends to the profitability change of an industry by decreasing the dismissals utilizing LSS DMAIC approach [60]. Lean Six Sigma method in a manufacturing lead time perfection projects. The objective is to improve working solutions for the company to develop its manufacturing lead time [61].

2.4.8. Barriers for Implementation of Lean Six Sigma

Absence of information and instruction – and, in part, misguided concepts around Six Sigma have made SMEs software manufacturing enterprises to be distrustful about the appropriateness of Six Sigma for them. Aside from these, there are some possible innovation, authority and money-related constraints that make the use of Six Sigma in that case a barrier by it. These are many barriers that can affect the implementation of the Lean Six Sigma example: lack of assets, internal protection, lack of administration from the top management, lack of general knowledge of Lean Six Sigma, insufficient hierarchical arrangements, cultural boundaries, poor preparations and instructions, the untrue notion that Six Sigma is excessive and confusing which renders it impossible to utilize, wrong impressions and attitudes about procedural parameters, Lacunae in information gathering and, finally, poor Six Sigma venture setting [62].

The four key shortages are, in order of importance: absence of best administrative practices, technical preparations, information, and the use culture [63]. According to Z Mallick ,et al. the biggest problems facing LSS implementation are based on the human factor such as these: new employees are hesitant, little effort is made to remove waste and top management indifference , insulating association from cross business , inadequate regard for interior and internal client, failure to change improper planning , lack of training lack of democratic talk [64].

Other experts believe the limited use of LSS is due to constraints in lean device and practices. Many essentially indicate administration-related difficulties, whereas some state that the specific roles and responsibilities of individuals have to be clarified as well as best-practice instruments [65]. Absence of planning, lack of best administration duties, lack of a proper methodology, unwillingness to learn, and other human aspects are the primary hindrances which need addressing in Lean manufacturing [66]. Also from the real hindrances in lean usage: equipment separate, work organizing, outer retard, poor material administration [67].

2.5. Comparison of Software Industry and Manufacturing Industry

The software creating process is a progress rather than a manufacturing one, which does not happen in the same way each time; whereas a manufacturing process is repetitive. In manufacturing, the making and distribution of an item is unceasing and continuing, requiring a similar harvest time again and again. Software making is essentially the design and expansion of a distinctive product regularly altered to suite the requirements of a particular consumer, over a one-off process.

Software improvement is a ‘manufacturing process’ that alters some unprocessed material (data or instructions) into functioning productions; nonetheless, the nature of unprocessed material is dissimilar and the alteration process is relatively not the same as that of a manufacturing industry. The unrefined material in the software development is information feedback which turns into a piece of software (program). The functioning material is the information yield from the program [68].

Such differences between software and manufacturing appear naturally, the main different properties are non-repetitiveness, exceptional input and output, intellect, imagining, and some external characteristics such as expert’s skills and knowledge

[68]. These changes reflect on the product as well as the process and do not imply that Six Sigma is perfectly appropriate for use in the manufacturing process. However, being mindful of them while applying Six Sigma in programming eliminates the troubles likely to occur. Indeed, Six Sigma is material to software organizations. To mention a few notable examples, Motorola has been making use of Six Sigma in its product division for a long time, and (Tata Consultancy Services) has also benefitted in the wake of applying Six Sigma [69]. Table 2.7 depicts the basic differences of LSS application in manufacturing and software development by Suppliers, Input, Process, Output, Customer (SIPOC) which is one of tools define LSS [70].

Table 2.7. The basic differences of LSS application by SPIOC [70].

Application /tool	**Suppliers**	**Input**	**Process**	**Output**	**Customers**
Manufacturing	Sellers	Unprocessed resources	Gathering	Produce	Consumers
Software Development	Investors	Necessities	Progress	Softwae use	Users

2.6. LSS as Applied to Software

LSS practices are appropriate in numerous situations, having been previously and successfully applied in manufacturing for more than two decades, and are acknowledged as a novel beginning to gain advantage over the rest. The commonly-held fallacy is that Six Sigma is only suitable for the industrial sector and, hence, the inclusion solicitation of LSS in software businesses has confronted countless disagreements. There are various diverse interpretations on applying Six Sigma in software corporations [68]. Colin N, 2005, It is tremendously significant that those having LSS practices in software development are conscious of the associations between software and classic lean.

2.7. Software Development

The energetic development of the info expertise in contemporary times has generated fundamentals for the institution of innovative models in the administration of software assignments. A distinguishing property of the process of software growth is that it is typically reliant on other software resolutions and produces in a production proposal. This necessity in a back ground of vibrant growth needs unceasing regeneration and obedience associated to other expertise [1].

Software development is a PC design process, certification, challenging, and remedies of any faults in the involving, the making and preservation of submissions and frame works resulting in a software product. Software making is the process of scripting and observing the source code, but in a larger sense and comprises everything that is involved amongst the notion of the program which is vital for the exterior of the final features of the program, and occasionally in operation and intentional business. It can cultivate software for a diversity of determinations, the three most collective determinations is to suite the exact requirements client / business (as is the case with custom software), to meet the requests perceived part the variety of possible consumers (as is the case with commercial and open source software), or to utilize a profile (ie, anybody can inscribe programs to mechanize the everyday tasks) [68].

The software production comprises numerous dissimilar measures, for instance, investigation, growth, preservation and exploitation of software. This section also contains software facilities, such as training, certification, and consultation [71]. Software expansion tasks are frequently applied by means of squads that have participants dispersed all over the sphere. Constructing software does not necessitate official face-to face communiqué. Assignment and task tracking is completed by way of exhausting online management means such as fundamental chaser, base camp or productive. Code type control is guaranteed by means of utilizing versioning tools such as SVN or GIT [72].

There are voluminous prevailing prototypes for the improvement of schemes for diverse task scopes and requests [73]. The study's objective is to solemnize the practice dedicated to the expansion of software framed concerned with invention

and recognized IT assignments. Interacted expertise intensely engrained in the beginning of creativity software expansion continues to cultivate through the eras, particularly under the all-new age of cloud computing [74].

Evolving price competitive software produces that suite extraordinary quality criteria according to the time constrained market place now a days is proven a challenging assignment. The solicitation of these practices and rehearses response to the prerequisite of decreasing hazards and up surging superiority and usability of the concluding software product [75; 76].

2.7.1 Software Development Stages

Making a software product is a progression containing many distinctive phases. Each phase has its own deliverables and is destined by an exact time border [51; 72]. Depending on the assignment, certain phases have supplementary heaviness in the overall exertion to establish the software product:

1. Research: It is the phase where the task proprietor, the task manager and the task team meet and exchange info.
2. Planning: It is the central route of accepting why a software scheme should be industrialized and defining how the project squad will perform making it.
3. Design: The design phase decides how the scheme will function (in terms of software, hardware and network infrastructure), the utilize interface and the exact programs, databases, and records that will be essential.
4. Development: It is the phase where code is printed and the software solicitation is actually made. The improvement phase begins with scheduling the expansion atmosphere and the testing atmosphere.
5. Setup: It is the step where the solicitation is built on the live environment. The setup stage follows the real utilization of the software product.
6. Testing: Throughout this period the system is truly built. It comprises system building, analysis, installation, and post-implementation support and improvement
7. Maintenance: the phase is cover software growth following the application arrangement and similarly this phase is accountable for safeguarding that the application is operative within the intentional restriction.

Alienated any software progress process into few logical stages that permit the business to progress software to establish their task professionally for building the essential software product purposes within the exact time frame and budget [77].

2.7.2 Software Development Life Cycle Models

A software progress life cycle model has main purpose such as extraordinary excellence product provided in time and offers strong control on quality, distribution and exploits the profit in terms of reducing cost on product progress [78]. SDLC is framework crucial tasks which are achieved at each stage in evolving software. SDLC describes a practice for refining the feature of software and the general improvement process. It is vastly significant to decide on the exact model in software development. A software development method commonly leads the designer via the software development process. A SDLC choosing principle is vital as it safeguards the association to exploit the alteration to provide software positively [9].

Every SDLC exemplary should support many categories' of schemes [78]:

1. Novel software solicitation improvement
2. Renovating the prevailing software product.
3. Package type adaptation or compatibility
4. Adaptation of prevailing system to new DBMS

The basic accomplishments or stages to be achieved for emerging a software system are [77]:

1. Specifying of System's Necessities
2. Design of system
3. Growth (coding) of software
4. System Challenging

This comprises carrying out safety procedures approved throughout the code life cycle to evade holes in carrying out security strategies or the primary system (weaknesses) through imperfections in design, improvement, utilization and modernizing, preservation or application database [79]. This article delivered supplementary steps and subsections of the original / traditional DSDM to assimilate security [80]. It can improve the software sanctuary system deprived of

damaging the factual core of attaining engineering safety of continuous participation throughout the graceful life of development with its function and the specific responsibilities of the cycle.

2.7.3 Critical Success Factors in Software Development Projects

Furthermost of the CSFs investigation exertion has concentrated on the consequences of software progress tasks rather than the process of evolving software itself. Nevertheless, it is perhaps competence and efficiency of the entire improvement course that regulates the result. Investigation has frequently concentrated on classifying nominee CSFs for project realization in numerous industries like engineering, industry and construction rather than concentrating on software improvement projects, however handling a software progress includes distinctiveness owing to the difficulty, orthodoxy, prices, perceptibility and suppleness of the software itself [81].

Practical difficulty interrelates definitely with consumer contribution and user support, none the less undesirably with project team duty, change administration, leadership attributes development team skill and mechanical vulnerability to essentially impact process success. The outcomes additionally signpost that technical difficulty interrelates with preparation and regulatory, comparative project size, requirement alteration to destructively upset product accomplishment [82].

Standing and explanation to produce precise results. Founded on the investigation of our widespread literature exploration, 26 serious achievement issues were connected to project achievement. There is a good opportunity , if an association or task manager is observant, to device the top five serious issues to drive towards assignment achievement since the percentage of incidence of occurrences for each is more than 50%. All these serious achievement issues were then gathered into three general groups, specifically, individuals' factor, procedure factor and practical factor [81].

2.7.4 Software Development Methodologies

Software progress approach is a manner of handling the software improvement assignment. Essentially, task supervision software improvement of each association is carried out in a dissimilar method, which is frequently a slight dissimilar from one task to another [83]. The Practice of software improvement or development of software engineering scheme is the structure that is utilized to assembly, plot and device the information system improvement process [84].

It has advanced further than the technology of the imaginings. All appreciations to the improvement of the software productiveness! The world of software improvement is immeasurable. The expertise is the faultless amalgamation of invention and thought that gazes at the notion of the creation of the boards, which is appropriate for the task of many software improvements [83].

The most established practices are often categorized by means of professional tools and methods. All approaches are provocative, as some individuals claim that any permanent approach is an outrage to an expert, imaginative, self-governing designer, though the others argue about which practice is the finest [85].

There are so many methods prevailing to choose a software expansion approach. Some of them are as follows [51]:

- Rule established professional system attitude
- Administrative Features based SDM selection attitude
- Big-M method
- CUQuP (Complexity, Uncertainty, Quality and Phase)

2.7.4.1Traditional Software Development (TSDM)

Software approaches such as waterfall model, V-model, spiral model and prototyping models are named traditional software development methodologies. These practices follow a consecutive sequence of stages-Necessities, plan, application, challenging, placement and preservation. Recording a steady set of requests is desirable at the commencement of a project. In other hand, we can say that TSDM rely on a set of predefined and ongoing processes documentation [9]. These methodologies are reinforced by means of a durable ground work before hand

coding and by trusting each stage in very touchable artifacts, offering documentation and vigilant confirmations and authentications [77].

2.7.4.1.1 Waterfall Model

The Waterfall model is a practice largely recognized as being devoted to software improvement. Its basics were first introduced by Winston W [77]. The Waterfall model is separated into stages, each organized as a set of actions to be taken concomitantly where the input of one stage is the consequence of the preceding stage and each stage has its own deliverables. Waterfall is predictable and values rigorous software planning [72].

2.7.4.1.2 Prototype Model (PM)

PM focuses its attention on making a definite program rather than concentrating on different forms. The models need larger participation of operators and permit them to perceive and interrelate with the model, in this way enabling them to deliver responses that are well-stipulated and more comprehensive [86]. The procedure commences with collecting the major practical necessities, followed by a rapid scheme leading to the extension of a prototype. The created samples, then, assessed by consumers/clients. Next, the designers revise the prototype till the client and consumers are satisfaction [87].

2.7.4.1.3 V Model

This model focuses on what is useful (and why), and whether the measure of action is appropriate to all records. V offers a framework outlining the associations among the necessities and subtle elements as well as test illustrations [84]. The abnormal state configuration is based on system building and the design phase; an integration test plan is created in this stage in order to test the pieces of the software systems ability to work together [88].

2.7.4.1.4 Spiral Model

In this model, instead of demonstrating a succession of exercises with backtracking and starting with one development then onto the next, a combination of exercises in a twisted fashion is applied [9]. The spiral model has four phases: planning, risk analysis, engineering and evaluation [87]. An item wanders on and on and continues to experience these phases in cycles called “spirals”. In the spiral model, the exact section addresses progress, and the scope of the twisting addresses cost [88].

2.7.4.2 Agile Software Development Methodologies (ASDM)

Presented another group of programming advancement philosophies, which alludes to dexterous procedures as to address the difficulties of future improvements in the software development. These procedures concentrate on the adaptability and flexibility depicted as exquisite, not at all like the traditional procedures that are required to roll out [89]. ASDM can be used not only form developing simple and small software but they are suitable for development of complex and big information technology systems. ASDM depends on the possibility of incremental and iterative improvement in which stage inside development cycle are returned to again and again The coordinated pronouncement was composed in 2001 which is based on [9]:

- Individuals and collaboration's over procedure and instruments
- Working programming over total report
- Customer joint exertion over contract transaction
- Responding to change over after a course of action

The main considerations as indicated by Agile statement on which the advancement is based are:

- Early client inclusion
- Iterative development
- Self-sorting out groups
- Adaptation to change

Demonstrate that a portion of the difficulties in the use of Agile standards in AGSD can be overcome using CC. Analyzes the real instances of SaaS selection of the distributed computing condition as an approach to bring out four new and best

practices for programming advancement including recognizing the best at present practices for operations being used [74; 75].

2.7.4.2.1 Agile Principles

The basis of the success of this methodology is its ability to adapt to the rapid change of requirements. Furthermore, there are a number of principles that lead Agile methodologies to deliver programs consistently and in high quality to satisfy customers. The twelve principles behind the Agile Manifesto give the software development groups a top-to-bottom understanding of what coordinated software development is in its essential form. This awareness gives a chance to development groups to maintain agile standards. A definite depiction of these detailed standards has been proposed by Siva Dorairaj and David Allen in what follows [89]:

1. The most priority need is consumer satisfaction through ahead of schedule delivery of profitable software.

2. Changing requirements is welcome, even late in the development. Agile procedures add to changing the competitive of the client

3. Working softwares are delivered as often as possible, from a little while to two or three months, with inclination to the shorter timescale.

4. Developers and designers cooperate every day all through the project task.

5. Undertakings are worked by propelled people given the earth and bolster they require with the assume that they take care of business.

6. The most productive and successful technique for passing on information to and inside a development team is up close and personal discussion.

7. Working software is the essential proportion of advancement.

8. Agile processes that promote sustainable development. Project providers, developers and users must maintain a constant pace indefinitely.

9. Constant attention is paid to technical excellence, while promoting good design of agility.

10. Simplicity - the art of maximizing the volume of work that did not happen is essential.

11. Best designs and requirements are shown by self-organizing teams.

12. At even intervals, the team thinks about how to turnoff more successful, at that point tunes and changes its conduct in like manner.

2.7.4.2.2 Analysis of Agile

Executing Agile is an entirely different methodology from the custom one. At any rate, not all agile strategies satisfy all the quality factors but, still, one system may fulfill different qualities and confirmation factors. The non-functional traits - that is, the quality components - can be expressed as:
Maintainability, reliability, scalability, ease of use, security, generality, efficiency, portability, time effectiveness, testability, reusability**,** cost effectiveness, and flexibility [90].

2.7.4.2.3 Agile Family

The goal of the Agile methods is to adapt to changing needs, reduce development costs, and continue to provide quality and reasonable software within fast projects with several releases all born in a very short period of extra time. Normally, all team members are involved in all aspects of planning, implementation, and testing. This is commonly achieved by small teams, maybe nine or less, in the form of daily interaction and face-to-face communication. They may also include representative teams of the customers [83].
Cover media and all people involved are required to finish the program. At any rate, this incorporates developers and individuals who know the product, for example, product administrators, business examiners, or real clients. It may include relievers in addition, testing, interface designers, technical writers, and management. Also, confirmation is made as to the flexibility of the working methods of the program and essentially as a measure of progress. With a preference to communicate face-to-face and ASD production, only minimal documentation is done in comparison to other methods [91].

2.7.4.2.4 Popular Agile Software Development Frameworks Include

1. Scrum

Scrum is a framework for Agile software used in the development of incremental and redundant software. The main advantage of the implementation of the Scrum system is that it has the ability to change the requirements of customers during the development process, which is repeated [92]. This methodology offers benefits such as reducing product costs and increasing payoff. The important processes on Scrum [93] are: product backlog, sprint, daily stand-up (meetings), and features delivered as required by clients. While the primary artifact of a Scrum is the final product itself, there are three other important artifacts used in the sprints: Product Backlog, Sprint Backlog, and Burn-down Chart [89].

1.1 Scrum Theory

Crowded thick-based control theory in experimental or experimental processes. Experimental states show that knowledge comes from awareness and suitable decision-making mainly on what is known. Scrum often uses the method, little by little, to improve the ability to predict and control risks. It adheres to every application within the three pillars for pilotting process control; these are: transparency, inspection, and adjustment [94].

1.2 How Does Scrum Fit With Agile?

Agile gave Scrum the simple independent definitions of whatever equipment we need to get the job done in the best way and help obtain the business results expected. Scrum opens the way to other valuable Agile practices, for example, Test-Driven Development (TDD) [95]. These points help organizations around the globe utilizing Scrum to be more adaptable. An Agile company does not really have a "business side" and a "the technical side" as there are teams working directly to provide a commercial value for the product through achieving technical excellence**.**

2. Extreme Programming Methodology (XP)

XP is one of the methodologies used in the development of software to determine the process of development in terms of where it is done, in what a manner and when and how; in other words, it is a process that provides principles and practices for the production of goods and sets the appropriate frequency for the organization of software within projects. XP is framework designed specifically for the individual needs of teams, projects, companies and others [88]. XP attempts not to go back in the development process and to keeps up with determining the final correct requirements and design before implementation [94].

3. Rapid Application Development (RAD)

RAD is an improvement lifecycle intended to give substantially quicker development and higher quality outcomes than those with traditional systems. It calls for an intense software development process with quick application advancements emphasizing less on arranging and more on improving. Development and time cycles can be developed several sessions at a time [72]. This methodology is uses concepts that serve as core elements [77] as:

1. Prototyping
2. Time Boxing
3. Iterative Development
4. Management Approach
5. Team Members

4. Feature-Driven Development (FDD)

FDD is applied by some companies with focus exclusively on the development of the already planned products instead of studying the market and seeing what the consumer can benefit. It receives reactions from project owners after the application is already configured, but the constant interaction between the development team and the project owner carries on throughout the duration of the project [72]. FDD is suitable for small and medium-sized businesses with the aim, as described in MSM, is to “deliver tangible, repeatedly working software, in a timely [73].

5. Iterative and Incremental Development

This methodology is based on the construction of the implementation program one step at that time in model expansion form in accordance to preliminary specifications for a basic model of the application. Unlike the prototype, the model will not be ruled out, but instead, it is stretched. After prototype testing and receiving feedback from the project proprietor, specifications are modified and the form expanded [72]. The procedure is repeated until the point that it turns into a completely useful application that meets every one of the pre-requisites of the plan of action. Various delivery augmentations are then characterized with every addition, thus giving a subset of functional pre-requisites [87].

6. Dynamic Systems Development Model Methodology

This method is centered on creating application frameworks that genuinely serve the requirements of the business. Dynamic methodology development technique is an iterative advancement display that uses a period box approach [77] with the mission to make SD frameworks inside the predefined time allotment and distributed spending plan [96].

7. Crystal Methods

Crystal Methods is a group of methodologies created around the hypothesis that individuals, and not instruments or processes, are the most imperative factor in any software venture [77]. These techniques are a set of processes that can be connected to various activities relying upon the size and multi-faceted nature of projects. One prominent example amongst the most adaptable methodologies in this family is the Crystal Clear, which predominantly centers around projects comprising 6 to 8 developers [97].

2.7.4.2.5 CSF's of Agile Software Development Projects

CSFs maintain that organizations ought to be vigilant when working with team members and merchants, particularly with those topographically scattered. It is

likewise vital to comprehend that not succeeding at Agile adoption the first run through does not imply that Agile does not work, but rather that a review ought to be held to survey why it doesn't work and what the exercises realized are, with the goal that it will work next time.

As to issue, the success and failure factors are: culture, project type and planning, customer involvement, team structure, and coordination's, mandate, stakeholder involvement and buy-in, lastly aptitude level and attitude of team members [98].
Through experimental research find that 1) Training and instruction assumes an essential part in advancing coordinated process change; 2) Agile strategies must be set up inside a dexterous culture, principally to allude to shared trust and participation of the corporate culture; and 3) Attention to the plan and utilization of cutting edge innovation don't get far reaching support [99].
The essential CSF and the sub-factor under every estimation pursue a predetermined number of success factors for more comprehend capacity and pertinence. Moreover, the success factors in Agile projects giving data analysis technique, and the calculation and flow chart for performing or executing the methodology in the form of organization, people, process, technical, and other project aspects [100].

In the process measurement, the factor does not expressly show up in the client driven issues and motivation; furthermore, continuous integration factor is mentioned in the principles, yet nothing else is specified about coordination with outside process as well as how to receive the Agile in an old process. This implies gathering prerequisites and coordinating them with the outside process is inadequately distinguished in dexterous standards. All the while and item measurements, there is no direct standard to Agile these elements, which are all about subjective and quantitative studies bringing about abandon individuals' and organizations' encounters and the issue of what is more important: project, people, process, technical aspects or organizational aspects [101].

2.7.4.2.6 Barriers Faced in Implementation of Agile Software Development

When programming as per administrative prerequisites, some of the hindrances to agile adoption are related with the way toward accomplishing administrative

conformity. All individuals from an organization ought to be prepared to go up against a considerable degree of difficulties in the changing process. These difficulties are, for the most part, in areas of hierarchical culture, administration, individuals and the process itself. The principle starting points of these difficulties are hierarchical culture and structure [102].

A few of these barriers are general authoritative resistance to change, absence of client/client accessibility, previous unbending structures, insufficient staff with Agile experience, worries about loss of administration control, worries about absence of forthright arranging, deficient administration bolster, worries about the capacity to scale Agile, requirements for advancement team bolster, and the apparent time and cost to make the [103]. Also, resources in various areas may make undertaking certain Agile procedures harder. In any case, there are methods for working around this obstacle. The challenges as seen by the Agile team include: communication, information progress, cultural contrasts, team attachment, and individuals versus process arranged, learning administration, documentation, recruitment difficulties, and match programming [104].

By utilizing the Agile strategy, development teams apply a lightweight procedure with emphasis on the fast conveyance of the business initiative. This helps companies essentially to diminish the general hazards related with the advancement process, and guarantee that business esteem is amplified. By ceaselessly adjusting the conveyed programming with the desired needs, groups can without much of a stretch adjust to changing pre-requisites all through the undertaking. Tasks can be executed with no spending limitation since nimble declaration expresses that the group is self-sorting out, meaning that groups work out the problems by themselves and, as such, there is no need for out-sourcing [105].

The effects that Agile approach has on software development forms as for quality inside the authoritative, systematic, and culture structure. Agile software development circles around advancing necessities achieved by coordinated client engagement in the process, quick cycles, and small but steady releases of product or its parts [106]. The progress in software development approaches incorporates more steady necessities, prior blame recognition, less lead times for testing, expanded correspondence, and expanded versatile limit [107].

2.8 Related Work

2.8.1 Six Sigma in Software Development

Research in the field is frequently alluded to as “Six Sigma”, and its utilization in software development is alluded to as the “Six Sigma program” system used to enhance, quicken, and maintain the program selection process. SS helps accelerate the testing and integration of product development aspects, enabling the delivery of high-quality products to consumers, at the same time making software projects transparent to both customers and management. As a result, after verifying transparency and finalizing the precise estimates of the project, both client deadlines and client requirements become much easier to meet [108].

A set of techniques is achieved used in SS to complete the task and deploy function quality in Agile development progress operations and jobs. It uses the transfer functions of the Six Sigma map to develop practical responses to project controls. The results are valid for all types of lean software development [109]. Integrate the tools of Six Sigma projects in the Scrum agile methodology by applying the Six Sigma Scrum tool models, thus improving the quality of results for clients [110].
The concept of SS and its industrialization, after interviews and many case studies to detail our approach, the results can be useful for software companies when applying SS in their companies to improve the process [69]. The utilization of the Six Sigma strategy reduces imperfections in maintenance projects within the software industry. The DMAIC approach has been followed here to solve the underlying problem of reducing the customer-reported defects in client acknowledgment testing period of the software development lifecycle. The work investigates how a software procedure can utilize a deliberate technique to move towards world-class quality level [111].

The applicability of the Six Sigma structure to programming, a few fantasies and realities about the Six Sigma Software Program (6SSP). Likewise, deal with some basic misguided judgments on the capability of Six Sigma in programming and, in addition, some real pragmatic difficulties software experts are presently confronting when deciding between product designs and using a process in which defects will

not add, and in the meantime adhering to the convention of screening out imperfections through quality control [112].

2.8.2 Lean Software Development (LSD)

The pace of the progress in the software development industry remains high. Individuals keep on pushing the limits of the known systems and practices with an end goal to create programming as proficiently and viably as could be allowed. In this vein, LSD has emerged as an option in contrast to extensive methods composed fundamentally for so large projects.

The LSD approach is the best methodology which can be utilized as a powerful tool for them. Lean offers quicker improvement as well as keeping up the quality of the product organization amid retreat in development [113]. The aim of this paper was to assess the principles primarily associated with the automotive lean lifecycle development program for software process improvement (SPI) [114].

2.8.3 LSS in Software Development

Lean and Six Sigma metrics in software development focus on reducing defects and improving the quality of deliverables and time to market. Scrum is an iterative and incremental agile software development methodology for managing software projects or products. Applying the Lean and Six Sigma metrics on agile projects have shown greater improvement in delivering quality products quickly to market [115].

Lean, acquired from the Lean manufacturing assembling setting, is a flexible methodology for change management, while the Six Sigma approach stresses ceaseless change as a feature to decrease defects within a system. It mirrors the Lean Six Sigma application and execution in the software industry, utilizing the generally accepted factual statistical and non-statistical tools, programming building instruments and different structures applied within the programming sector. Additionally, it analyzes a portion of the basic achievement factors (CSFs) for fruitful Six Sigma applications in the software /IT industry. The examinations reveal that LSS, when utilized to attain operational efficiency, can accomplish more than

simply enhancing the process by focusing on incorporating programs in practical terms -as opposed to the hypothetical premise or a motivationally-based notion [116].

Applies Six Sigma methodologies for WFP operations using hybrid simulation. It uses relatively detailed empirical information to develop software Agile and Lean methodologies for products 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 [117].

LSS application and its application in the software industry, utilizes the commonly taken statistical and non-statistical measures and software engineering tools and frameworks in the sector. The two unique initiatives: one for a full software development life cycle and the other for one of the stages within the development process. Both these cases have brought out quantifiable enhancements through active usage of the integrated Lean Six Sigma in a continuity-change paradigm [118]. However, using Lean Six Sigma to deal with various settings in the development process for Information Technology Service Management (ITSM) remains generally untested [45].

LSS methodology has been discovered for more than two decades. It is successfully and continually used in manufacturing and industry. Recently it was spread to many other fields. There's a lot of literature on LSS and Agile separately, but I couldn't find a good comparison between the two frameworks–possibly because few folks have significant training and experience in both subjects. Looking at the results obtained from LSS applications in software development, we found that there are few theories that explain the reasons for success and failure, so it is required to develop a framework which will attempt to build a theory of how and why LSS works in Agile software development.

CHAPTER 3

COMBINING LEAN SIX SIGMA WITH AGILE

3.1 Introduction

The aim of this study is to merge two different approaches in the roots and combine them with some of the principles and systems used by the work team to accomplish administrative or developmental tasks for projects/ in order to do so\ we will present the stages included in each approach during the implementation, how to implement them and the most important difficulties to be faced in this regard.

3.2 The LSS Approach

Lean Six Sigma is the mixture of the Lean approach and Six Sigma approach to form a new one in order to harvest the favorable properties of each methodology and, thereby, enhance an overall process. LSS offers two general strategies: one for building up another venture or process design, in other words Define, Measure, Analyze, Design and Verify or DMADV; and another one for enhancing a current procedure since attention are primarily on enhancing a certain process that is Define Measure, Analyze, Improve and Control or DMAIC.

3.2.1 DMAIC Methodology

DMAIC is information driven quality change method to redesign the profitability and sufficiency of a process. It have stages, the stages are describe in the following Fig. 3.1.

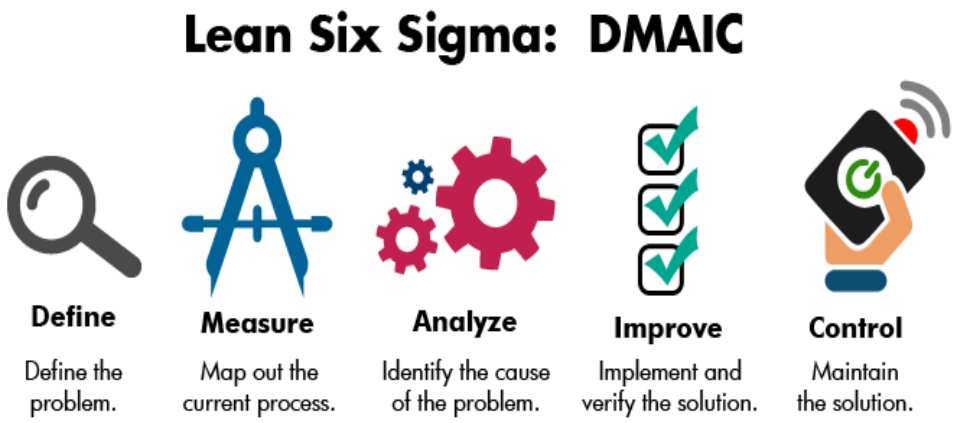

Figure 3.1 The stages for implementation LSS: DMAIC [119]

3.2.1.1 Define

In the define stage, the LSS venture team distinguishes a task in view of business targets and the clients of the procedure and their needs and necessities [68].The plan is to identify reason, recognize and set quantifiable objectives from the viewpoint of both the developers and partner, create timetables and rules for survey, and detect and evaluate the possible threats and risks likely to arise [120].

The main tools utilized in this stage are:

- Project Charter
- Process Flowchart
- SIPOC Diagram (Supplier- Input- Process- Output- Customer)
- Stakeholder Analysis
- CTQ Definitions (Critical To Quality)
- Voice of the Customer Gathering

3.2.1.2 Measure

This stage encompasses process mapping, operational definition, information accumulation graphs, appraisal of the present system, and assessment of the present level of process pursuant. The measurement is one more advance in the best approach to settle on a reality based choice [111; 120]. Measurement happens at

three distinct phases of process inputs, process and outputs. The main tools utilized in this stage are:

- Check sheet
- Control charts
- Failure modes and effect analysis (FMEA)
- Histograms
- Pareto charts
- Prioritization matrix
- Process cycle efficiency

3.2.1.3 Analyze

This stage examination the data that were gathered in the measure stage and through this stage, the team can decide on the reasons to change certain requirements and how to fix the uncertainties between the existing execution and the coveted level of execution [111; 120].

The main tools utilized in this stage are:

- 5 Whys Analysis
- Affinity diagrams
- Analysis of variance (ANOVA)
- Cause-and-effect diagram Control charts
- Pareto charts
- Pugh Concept Selection Matrix
- Regression analysis,
- Root cause analysis,
- Scatter plots
- Value stream mapping

3.2.1.4 Improve

At this stage, the plan is to recognize, assess, and select the correct change arrangements. Concentrating on the underlying drivers recognized in the Analyze

stage, the task team creates and chooses an arrangement of solutions so as to enhance Sigma execution [111; 120].

The main tools utilized in this stage are:

- Brainstorming
- Mistake Proofing
- Design of Experiments
- Pugh Matrix
- Quality Function Development (QFD/House of Quality)
- Failure Modes and Effects Analysis (FMEA)
- Simulation Software

3.2.1.5 Control

The Control stage is intended to bring into effect the last arrangements and guarantee the maintenance of recently-enhanced procedures with the goal that the enhanced Sigma execution can hold up over time [111; 120].

The main tools utilized in this stage are:

- Process Sigma Calculation
- Control Charts (Variable and Attribute)
- Cost Savings Calculations
- Control Plan

3.2.2 Organizational Structure of LSS

The LSS approach is client- driven; the Sigma ability is a metric which shows how fully the technique is being performed, and the hierarchical framework is a basic model in the execution of the LSS ventures. Many know-how roles as shown below Table 3.1.

Table 3.1. Organization roles structure of LSS

Roles	**Description**
Sponsor	Administration, and delivery, provides and adjusts assets (Black Belts / Green Belts, Team Members) and guarantees cross-practical coordinated efforts.
Leader	General management, a senior-level official who is in charge of actualizing the LSS inside the business.
Champion	Managing Director (M.D) a senior official who monitors the outside and interior components influencing the business.
Black Belt	Head of Quality, full-time position providing supervision for the venture group, oversees venture correspondences.
Master Black Belt	Oversee quality, part-time or full-time position providing mastery on LSS apparatuses and procedures, including project administration and change administration.
Green Belt	Manager operation or team leader-operations, part-time position providing leadership and initiative for the venture group, oversee venture interchanges.
Team Member	Individuals cooperating when using LSS systems, includes part-time.
Process Owner	Helps to materialize potential LSS ventures and holds claim over arrangement conveyed by the project team
Finance Analysts	Part-time positions responsible for allocating finances to the project

3.3 Agile

Agile methodologies center around the adaptability and versatility and are described as elegant features, not at all like the traditional processes where making changes is a requirement [89]. Agile implementation is a so different methodology from the traditional one, yet not all the Agile methods can fulfill the quality factors expected for inclusion in projects. This is because one methodology may satisfy the multiple qualities assurance factors, whereas others cannot [121]. Agile methodologies can

be utilized not only for developing small and simple software, but also for the development of huge and complex IT systems. Agile methodology relies upon the likelihood of incremental and iterative developments, in which the stages inside the development cycle are returned to again and again [9].

In the last few years, Agile practices have a significant impact in developing software. A great deal of affirmative response has been noted from organizations that use Agile practices, which are quite popular for producing evolving software products [122]. The 12 principles behind the Agile Manifesto provide the software development teams with an in-depth understanding of what ASD is all about. However, a thorough understanding of these principles is necessary in order to allow development teams to apply Agile values and principles during software development [89; 123].

The Agile procedure takes after the software development life cycle throughout the entire process. In this respect, consumer loyalty is at most required for better and shorter improvement time.

Table 3.2. Depicts the software developmentnof Agile phases [124].

Phase	**Description**
Define	Figure out what work will be done in the present cycle.
Design	Plan how to incorporate the necessities within an item.
Build	Make the outline a reality.
Test	Verify the item functions as designed.
Release	Hand over the product to the customer

There are many approaches through which we can bring agile projects to life. The intricate techniques are centered on various parts of the software development life cycle. In some cases, there is emphasis on the practices (such as extreme programming match programming), while others center around dealing with the software ventures. In this respect, one of the best known Agile strategies, Scrum, deserves further attention.

3.3.1 Scrum

The Agile Scrum method prescribes an experimental way to deal with software development with models, short conveyance cycles and utmost customer inclusion. The purpose is to guarantee the arrangement of deliverables in accordance to the customer's needs. On top of it all, this strategy offers the advantage of decreasing the cost associated while generating more income [15; 116].

The method begins with gathering the prerequisites from the clients and working out the general outline model of the assignment. The model is given a fair amount of thought as to the extent of the software. The next stage is to make a note of highlights as desired most by the customer [125]. An undertaking with the Scrum strategy starts with a portrayal of the framework to be implemented as we see it in Fig 3.2. At this, point, the project owner portrays the business procedure or plan into a product backlog [11]. This is a list of potential programming highlights or prerequisites for engineers to operate with in accordance to values and threats.

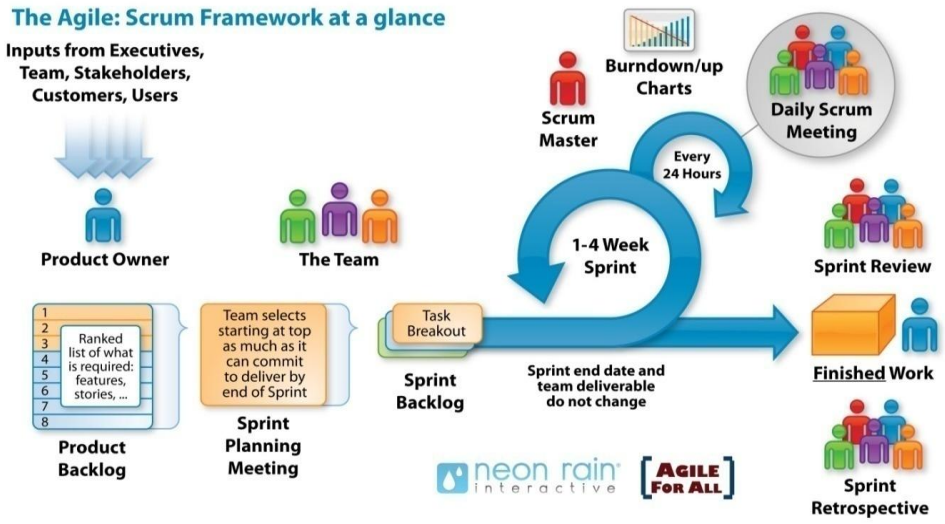

Figure 3.2. The general framwork of the practices of Agile Scrum [126].

3.3.1.1 Role Scrum

Typically, a Scrum group (generally known as "Scrum") is made out of five to nine individuals. At the point when a group has at least twelve individuals, the group is

rearranged into smaller forms that work autonomously; however, they are all in contact every now and again through the span of the task [127].

In the role Scrum, there are 3 parts: product owner, Scrum master and the team member [11]. Working alongside several members of the development team. In what follows, Table 3.3 highlights the descriptions.

Table 3.3. Role Scrum

Roles	**Description**
Scrum Master	They are the guides inside their group. They advise the group, the product proprietor, and the business on the procedure and search for approaches to adopt the routine exercises accordingly.
Team Member	Scrum groups are the champions for maintainable improvement initiatives. The best scrum groups are tightly-woven, co-dependent and, as a rule, 5 to 7 members. Team members have a varying range of abilities, and broadly educate each other so no individual can create a bottleneck in the process of working.
Product Owner	The item proprietor is the owner and concerned with business and market necessities, as such organizing the work to be finished by the engineering team in accordance to such concerns.
Stake Holder	Works with the product owner to maintain and make up for possible product backlog and to go to sprint planning gatherings as expected to offer suggestions and skills needed.

3.3.2 Agile Scrum Phases

Here, the five stages of the Scrum technique are depicted in detail, including data sources, devices and other related items. In each process, some information, devices

and yields can be required regardless of the nature of the sources, supplementary or not [124].

Initiate phase: The motivation behind this stage is to build up the venture vision, to set up ambitions, and to get financing.

Plan and Estimate: This stage surveys the different measurements of the undertaking while creating extra product backlog.

Development: This stage comprises different sprints to create augmentations of item usefulness. Each sprint begins with a planning meeting and is, eventually, wrapped up with a review session.

Review and Retrospective: At the point when ventures are building complex, exceedingly architected programming's or when numerous teams cooperate to create a new product, product backlog to form organizing models and designs are worked on in the few initial sprints by just one team. Then, this team is broken down to form new groups and logical data for item development is provided to each group.

Release: prior to this, the plan calls for a review of item's features with respect to costs, anticipated advantages, dates, and potential usefulness. Toward the finish of each development sprint, the product proprietor surveys whether such usefulness can be materialized and if the time is appropriate for it to be released. If all goes in accordance to these criteria, then release is made.

Yet, after significant achievements in the field of development and rapid progress, especially in dealing with the needs of the client, Agile supporters found some flaws in applications in later stages. Agile methods are not appropriate for the maintenance and Greenfield engineering designing and, consequently there won't be any documentation of the system. The focus is on working with the program without proper reporting and the possibility of deviation from the plans which can bring about undesired results. For this, the Agile system is not reasonable for some ventures where the correspondence between the client and the engineer is not stable or where there are amateurs in the development group.

To overcome this problem, efforts were made to add or integrate other methodologies such as: Six Sigma and Lean, for coordinated efforts and close interaction among the individuals involved in order to change certain aspects if

necessary and create new directions and make use of, if need be, other experts with outstanding capacities and experiences.

3.4 Combination of Agile and Lean in Software Development

Looking at Lean and Agile at a comparative level, one can find that the two can be joined at either the guidelines level or at the training level. More instances of joining the two at the training level have been reported. When consolidation takes place at the training level, depending on the circumstances there can be two diverse methods for joining the Lean and Agile practices. In this regard, Lean procedures can be combined with Agile programming features, such as "Lean inside Agile", Pursuit in Agile, etc [128]. The confirms various compatibilities amongst Lean and Agile, notwithstanding entrenched practices in Agile, Lean reasoning has conveyed new components to software development, for example, Kanban and work-in-progress limits, a more grounded accentuation on straightforwardness and shared advancement. Scaling adaptability, business administration inclusion and waste decrease were found as difficulties, while setting up teams, self-association and strengthening seemed less demanding to accomplish [129].

The obvious presence of Scrum and Lean Software Development (LSD) (Sutherland) suggests that this specific approach is a decent and promising technique for beginning investigations into the links between Agile Software Development (ASD) and LSD. In a similar way, this approach can be utilized to relate other ASD techniques to LSD and, thereby, improve the general impressions as to the connection between these two standards. At a much broader level, a look into utilizing the LSD properties can be extended to the connection between LSD and other software development approaches present today. From an industrial point of view, the LSD esteem sets may likewise be applied to different branches of software development with the ultimate goal to research the "leanness" of a specific approach or technique in action. This is especially critical in light of Fowler's (2008) proposal in the work titled “Identifying lean programming advancement esteems” [130].

3.5 Combining Six Sigma and Agile

Six Sigma and Agile are both approaches; yet, SS is a process improvement philosophy though Agile is a software development strategy. Applying Six Sigma in a procedure means to enhance the process ability by lessening the varieties –in away, to control them - in the procedure. However, applying Agile strategies in software development plans is intended to achieve incremental improvement by empowering fast and adaptable reaction to changes. Simply can utilize some of the best practices of Agile of like Scrum gatherings while using Six Sigma. Agile engages teams to persistently re-design their output to upgrade incentive as the project goes forward, enabling them to be as aggressive as they can be in the commercial market. The focal idea behind Six Sigma is that "absconds" can be estimated in a procedure [131].

Scrum and Six Sigma have both demonstrated their potential to clients in different settings [110]. Such as combining methods as part of a development plan for software, functional size measurement, and some steps to completion and quality capacity deployment intended to make coordinated improvements both lean and measurable [109].

3.6 Combined LSS and Agile

LSS and Agile supplement each other and, together, they can help companies to materialize changes in operational aims, namely:

- Support incremental changes with a procedure outlined around iterative delivery;
- Tighten criticism circles in process administration and change endeavors;
- Accurately measures esteem age and unequivocally connect to key tasks;
- Align venture portfolios with genuine, grounded business needs;
- Improve the speed of executing changes throughout the process.

3.6.1 Agile Execution of LSS Process

All things considered, it goes without saying that Agile is completely incongruent with LSS; both aim to cut waste from processes. Yet, one may ask whether these two can co-exist. Agile is rooted in IT whereas LSS stems back to manufacturing. Can they shape a harmonious relationship and make software development a more smooth and slender process? The proposals for change in this respect – one has to remember – must be directed toward constant review of true necessities as dictated by the business and clients involved. Some of these concerns are:

- Minimizing risks through iterative advancement and incremental delivery;
- Ability to deal with change past the start of procedural tests;
- Focusing and refinement of suggested enhancements at the usage level;
- Determining the ideal stage for development and new item presentation;
- Supporting entire lifecycles through maintenance as progress is made;
- Development team makes close coordination between business and IT

In turn, LSS offers other benefits for precise execution of the project; these are:

- A more fundamental project vision and a clearer core interest:
  Item backlog with quantifiable values.
  Item backlog prioritization criteria.
- Stronger business cases:
  Quantitative appraisal of highlight esteems.
  Clear linkage of IT endeavors to business benefits.
- Means to gauge achievement:
  Key measurements known for certain procedures.
  Estimation and control frameworks setup.
- Directed portfolio plans:
  Selecting activities in view of basic process requirements.
  Adjusting the extensions crosswise over practical storehouses.

3.6.2 Integrating Scrum into DMAIC

Scrum is chiefly basic with respect to the virtue of its engineering, while Six Sigma is centered on achieving major items execution by decreasing the variety level. The

blend of these two ideas can be overwhelmingly capable of primary applications, essentially on the grounds that Scrum has a solid arrangement with lean standards [10].

Lean Six Sigma has to not only concentrate on how to make constant changes and assess the procedural execution alongside business concerns,, but also to reaffirm in general the engagement and inspiration of those involved. In this manner, the two ideas can join and supplement each other, bringing about increased benefits and optimal results by concentrating on ideal quality product and performance as well as establishing metrics based on statistics.

LSS deals with solid and persistent change in the assembling procedure. Then again, Scrum deals with the so-called “people” aspect; its substance encompasses its procedure and profoundly affects individuals' conduct; it influences the level of duty in ventures with a tendency to encourage the choice of new thoughts. It stands against protection from change.

Keeping in mind the end goal to apply Scrum in a LSS project, we examine the relationships that exist among the different aspect of these two concepts.

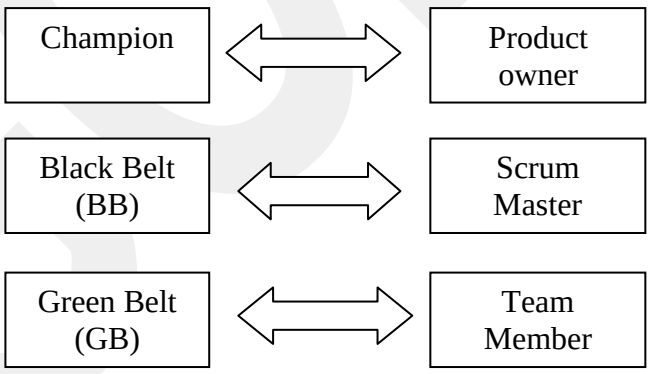

Figure 3.3 Integrating Scrum and DMAIC certification

3.7 Three Models for Combining LSS with Agile

(Arlen Bankston) It is possible to combine LSS and Agile by proposing models to count on Initial Approach, Operational Approach and Integrated Approach, It is in

this sense that we categorize and research these approaches in this study. Lean Six Sigma and Agile exist in a large number of structures and deal with some comparative concepts. There is, for the most part, more accentuation on numbers and meticulousness in LSS than in Agile, which is more about patterns, instincts, connections, and people. Building Agile into Lean Six Sigma procedures isolated to three models depend by some principle.

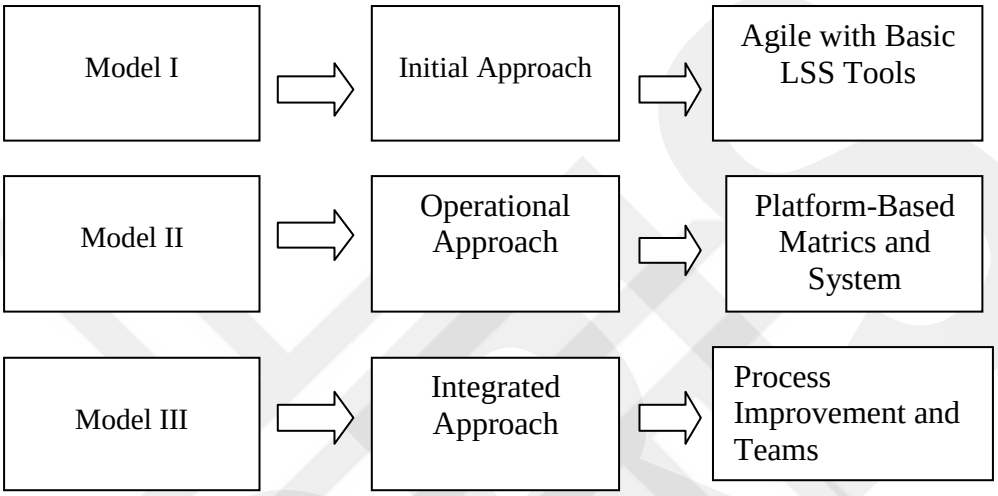

Figure 3.4. Models LSS and Agile combined

3.7.1 Model I

Thomas 2010 utilizes a broadened type of the QFD framework which records all arranged and finished client stories as controls, tracks all excesses, and determines the missing aspects that exist within the business owner's profile regarding current venture objectives in software development. In the following, Table 3.4 demonstrates series of imperative Six Sigma tools able to be adopted throughout Agile Scrum periods of software development [109].

Table 3.4. Lean Six Six tools and Agile combined.

LSS Tools	**Usage**	**Role Owner**	**Agile Phase**
Quality Function Deployment	This can be utilized as a part of prioritization of stories and to plan arrangements.	Product Owner	Planning Phase
Critical to Quality	To be used as a part of the prioritization of stories given by the client.	Product Owner, Scrummaster,Team Members	Planning Phase

The voice of the Customer	Helps in a clear understanding of the client's requirements by the team.	Scrum Master, Team Members.	Planning Phase
Brainstorming and Affinity Diagrams	This instrument can help engineers to accomplish different plan arrangements and acquire the ideal one through everyday meetings.	Team Members	Development Phase
Fishbone Diagram	Serves to ostensibly demonstrate the various potential purposes behind a specific issue or effect. It is particularly important in a get-together setting and for conditions in which negligible quantitative information is accessible for analysis.	Scrum Maser, Team Member	Development Phase
The Cause-Effect Diagram	This diagram is arranged to collect ideas from the task team with respect to what they feel are the main drivers behind the fluctuations in the Sigma execution and find the key factors.	Scrum Maser, Team Member	Retrospective Phase
Failure Mode and Effects Analysis	As new prerequisites are accumulated choice made in one cycle, in light of the necessities as comprehended up to that point, may turn into a hazard. By keeping up an FMEA for the outline and by assessing it at every cycle, the advancement group will have the capacity to guarantee that numerous potential failure focuses are dissected early.	Scrum Maser, Team Member	Retrospective Phase

3.7.2 Model II

This model focuses on the use of LSS matrics and system as to the improvement (DMAIC) or design (DFSS) approaches in Agile systems using LSS tools for optimization purposes as there are the advantages of both familiarity and compatibility with Scrum and also Extreme programming.

Lean and Six Sigma matrices can be integrated in Agile methodologies, further offering better process control, higher productivity and viability to recognize and resolve surrenders, for example: lack of resource and documentation, low of plan, lack skill of management...ect, ahead of schedule as could be expected under the circumstances and as proficiently as it can be possibly carried out [11].

3.7.3 Model III

At the basic level, LSS is about process improvement and critical thinking. A DMAIC-based venture is particularly tied in with enhancing a current procedure and taking care of issues, which brings about presenting changes and, hence, can be huge and typically marred with numerous difficulties and dangers.
In the same way, there exists a major degree of vulnerability and risk in a DMAIC venture most of which cannot be properly traced and spotted in advance by the stakeholders. Should one consider a DMAIC-based venture as a routine and normal undertaking, in a product improvement team, then no other chance can be seen in tackling its vulnerability and major fluctuations than with delicate methods. This is where procedure augments as techniques prove to be useful.

The ordinary DMAIC guide suggests an arranged model for overseeing Lean Six Sigma projects testing in accordance to the extent of the project and how large the changes are to be presented. Obviously, the extent of the issue and the other elements adding to the problem cannot be ignored.

An attempt is made in this model to integrate LSS with Agile methodology by relying on a set of previous studies that show the similarities and differences in the stages of implementation of the two approaches to try and adopt a new approach called (LSS-Agile) methodology.

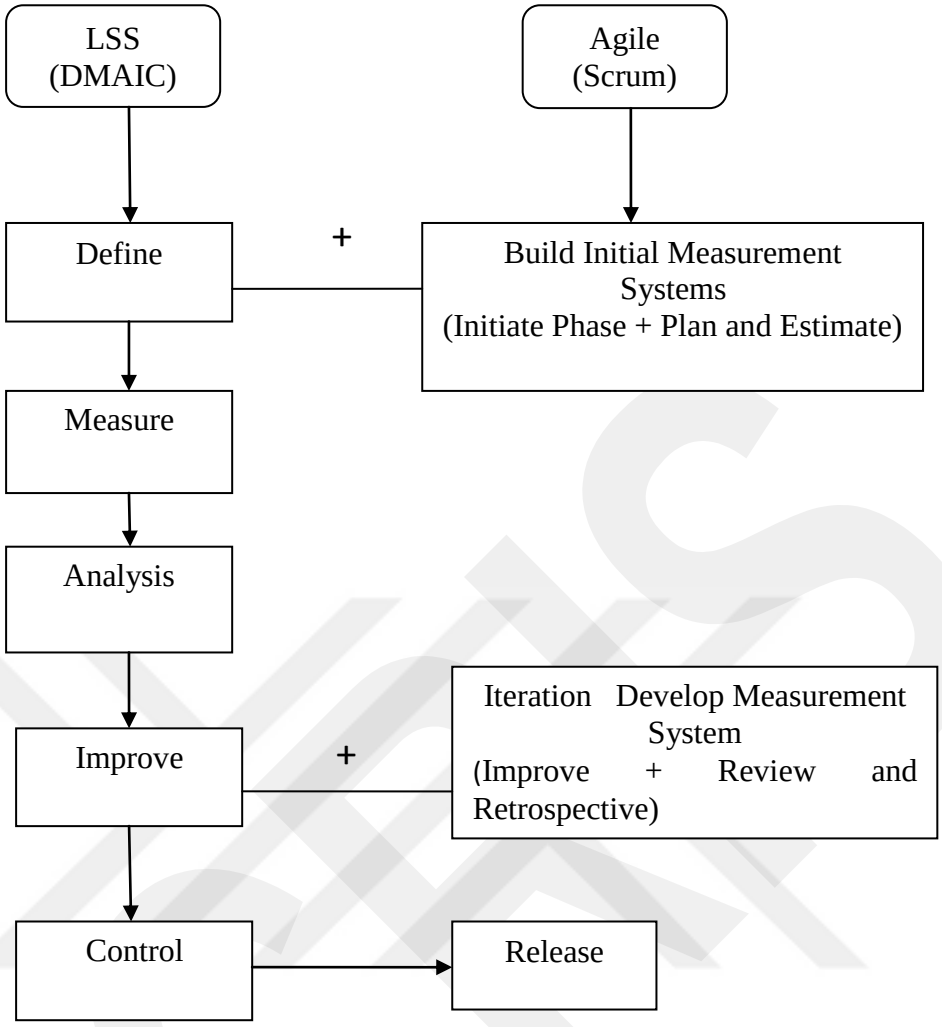

Figure 3.5. LSS-Agile

Thus, the model combining the LSS and the Agile can be clarified in five stages, as follows

Phase 1: LSS project team to build up the Agile project vision, recognize and set quantifiable objectives from the viewpoint of both the developers and partner undertaking while creating extra product backlog.

Phase 2: The main focus of the measure phase is to confirm that the data you are collecting is accurate. We have to gather data to examine to assess the hypothesis in the first stage. Measurement happens at distinct phases of process inputs, process and outputs, for example:

Table 3.5. The mauser phase is summrized by SIPOC diagram.

Suppliers	**Input**	**Process**	**Output**	**Customer**
Stakeholders -Technical department in a number of companies -Project owner -Project team	Requirements -Survey -Hardware -Software -DMAIC tools -SPSS	Developmnt -Analysis data	Software Application -Defects Causes -Evaluate and compare group results	Users -Software development companies -Project owner -Software users -Software developers

Phase 3: The team can decide on the reasons to change certain requirements and how to fix the uncertainties, verification incorporates both process analysis and data analysis and has to be finished before executing solutions.

Phase 4: The plan is to recognize, assess, and select the correct change arrangements, different sprints to create augmentations of item usefulness when numerous teams cooperate to create a new product concentrating on the underlying drivers recognized in the Analyze stage, the task team creates and chooses an arrangement of solutions so as to enhance LSS and Agile execution, we can see example in Table 3.6

Table 3.6. Improvement solutions by focusing on the root causes identified in analyze phase.

Gaps	**Combined LSS and Agile**
Lack management control	Use Lean Six Sigma tools to discover and control root causes within Agile projects.
Requirements is not clear	LSS Black Belt acts as customer proxy, assists with translating high-level goals to effective user stories.
Process needs	LSS aligns actions with hence process needs Agile supports test-and-learn approach through early operational exposure.

Team work	Champion ⟶ Product owner Black Belt ⟶ Scrum master Green Belt ⟶ Team members
Changes in improvement	Lean Six Sigma is not about sacred goal setting and it provides rounded project vision and clear focus. Lean Six Sigma needs a metric system that adjusts to moving targets. Working on the Agile team stable visions is always subject to change.
Selection criteria	Scrum is focused on the people and communication necessary to ensure effective creation. LSS is focused link of business strategy and organizational.
Limited scope of knowledge about methodology	Focusing and careful understanding of the Sigma team's initial principles in the measurement and analysis phases and analysis takes place in parallel to delivery.

Phase 5: Bring into effect the last arrangements and guarantee the maintenance of recently-enhanced procedures, the product proprietor surveys whether such usefulness can be materialized and if the time is appropriate for it to be released. If all goes in accordance to these criteria, then release is made.

This chapter deals with the most important stages of the implementation of Agile and Lean Six Sigma and presented the most important previous studies that dealt with the subject of the merger between Agile and Lean, Six Sigma the result of this goal and then the classification of the integration into three main themes and consider the third model as a new design to link the stages of the implementation of the two methodologies.

CHAPTER 4

RESEARCH DESIGN

4.1 Introduction

This chapter explains the design applied in our research in terms of practice, and explains the strategy and methodology used to collect data and sampling techniques with emphasis on the validity and reliability of data, as well as details about the development of the instrument and analysis some hypotheses of methodologies.

4.2 Research Strategy

The research strategy of this research project is based on the quantitative approach and includes the gathering and analysis of numeral data and application of statistical tests. The focus is mainly on measurements of the ordinal and nominal scale of the subject matters. As commonly known, in research this strategy is more clear, transparent, and easy-to control because of the use of questionnaires, which are arranged, verified, and presented statistically [132].

4.3 Research Methodology

A survey is characterized as the collection of data on various units and as a rule at a solitary crossroads in time, with a view to gathering methodically an assemblage of data in regard of various factors which are then inspected [133]. The features of benefit in the questionnaire employed in the present thesis are as follows:

- Moderately simple to oversee;
- Can be regulated remotely by means of the Internet, cell phone, and email;
- Operated remotely, which can lessen or avoid geographic reliance;
- Equipped for gathering information from an expansive number of respondents;
- Can be produced in less time;
- cost-effective;

- Multiple items can be asked about the study, proving more flexibility in analyzing the data.

4.4 Measure

The principle of the measurement stage is to ensure the accuracy of the data it collects.

The measurement stage is carried out with the following steps:

- Selecting the sampling to measure
- Creating a data collection plan
- Ensuring the data is reliable
- Collecting preliminary data

4.4.1 Data Collection

4.4.1.1 Design of Questionnaire

This research was based on the data collected from a web based self-report survey questionnaire made up of multiple sections and questions. The survey was designed to obtain answers to the specific research questions outlined in Appendix. The questionnaire included a number of different sections seeking information on various aspects of the study methodology (Lean, Six Sigma, Lean Six Sigma, software development methodologies, Agile and Scrum). The questions were formed in multiple-choice and a number of open-ended questions, with the general questionnaire structure as in the following:

4.4.1.1.1Introduction of Organization

This part looked for information about the company of the respondent how work it in terms of the size, types of project, position, service areas, number of software and the nature of business.

4.4.1.1.2 Items Related to LSS Program

This section is divided into two parts: the first (Ba) is around Lean and Six Sigma with questions regarding the role and experience of Six Sigma, number of projects,

its benefits and satisfaction with Lean and Six Sigma in companies. The second part (Bb) is about Lean Six Sigma and covers questions regarding the reasons for initiating, experiences, knowledge, barriers that faced LSS implementation, benefits of LSS program, implementation stage of LSS program, success factors, and benefits.

4.4.1.1.3 Items Related to SDM

This section is divided into three parts: the first one (Ca) is concerning software development methodologies and included questions regarding the number of years of experience, type of SDMs undertaken, benefits and success factors. The second part (Cb) is around Agile, such as: tools, satisfaction, projects' requirements, benefits and success factors**.** The last part (Cc) is related to Scrum, such as the type of projects, nature of requirements, role of the project and Scrum practices.

In this way, clarity and sufficient information gathering is ensured about the importance of some principles and concepts and their impact on the implementation of these methodologies in the software development sector. Also, whether the ways and concepts in these methodologies agree and each method can achieve to greater levels in the field of software development.

4.4.2 Development of the Instrument

The steps presented in the development and validations of the measurement scale are appeared by method of a flowchart in Figure 4.1

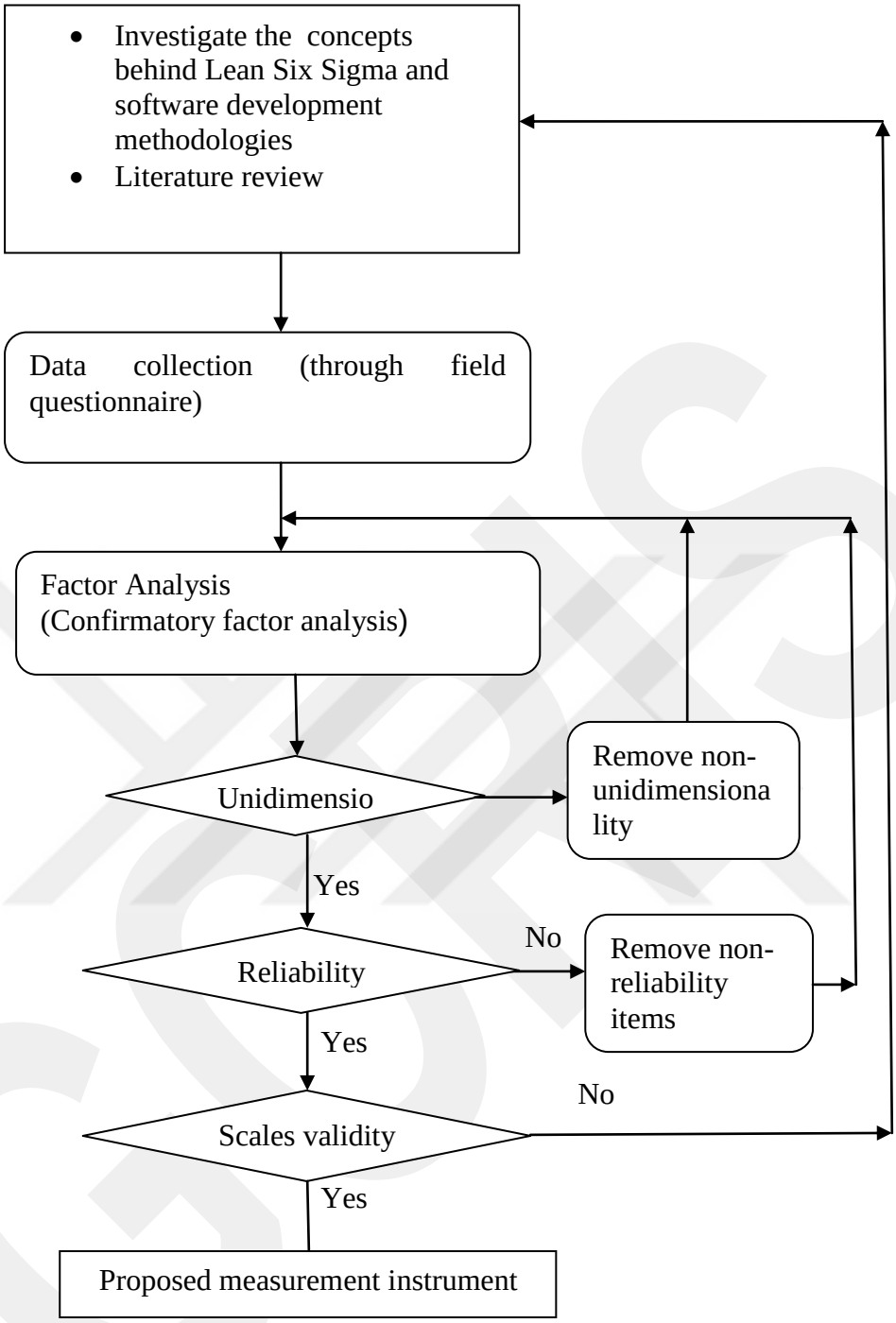

Figure 4.1. Development of the instrument

4.4.2.1 Factor Analysis (FA)

FA is helpful for surveying what hidden builds the things in every module are measuring, and where redundancies may happen. Cronbach's alpha is by and large utilized as a measure of the unwavering reliability of an arrangement of inquiries in a study instrument. It quantifies the interrelatedness of a set of things, despite the fact that a high incentive for alpha does not suggest unidimensionality [134].

4.4.2.2 Validity and Reliability

In research studies, validity is about the exactness and honesty of logical discoveries. A substantial examination ought to show what really exists and a legitimate instrument or measure ought to really gauge what it should measure [135].

As to reliability, this is about the consistency, robustness and repeatability of the sources and the analysts' capacity to assemble and record data strictly [134]. It indicated to the capacity of a research strategy to yield reliably the same outcomes over rehashed testing time. In different words, it requires that researchers utilize the same or relatively the same strategies and obtain similar outcomes each time they apply the methods on the same or practically identical subjects. It additionally requires that the analyst has created steady reactions or propensities in utilizing the technique and scoring or rating, and that the components identified with subjects and testing methods have been figured out in order to decrease errors in evaluations [135].

4.4.2.3 Dimensionality

Unidimensionality is certain observed factors are related in any event, case, or research topic. A set of items can reflect at least one measurement. Dimensionality alludes to the structure of a particular phenomenon. Uni-dimensionality, specifically, is about one dominant latent variable or phenomena. There are many statistical procedures that assist in searching for and examining a group of factors (e.g., factor investigation) these methods preferably receive a fair number of measurements to legitimize the utilization of composite scores and to clarify the

example of relationships among the factors being examined. In other words, it is assumed that if two test items are correlated, they have something unobserved in common [136]. A Comparative Fit Index of 0.90 or above for the model suggests that there is solid confirmation of uni-dimensionality.

4.5 Sampling

The data collected from the industry and software development departments, which included companies that have implemented the LSS methodology and those applying the Agile approach. Some of them run out of multiple, including LSS and Agile. The respondents include leaders of software development teams, main development team members and project managers. Atotal of 312 questionnaires were sent to different companies in Turkey, Canada, Malaysia and UK for collecting data related to the research project. Out of 312 questionnaires, 115 valid responses were received A total of 115 responses have been obtained from 52 were from 21 software companies applying LSS, 48 respondents from 23 Agile software companies, and 15 from 11 companies that implemented both (Agile and LSS).

4.5.1 Analysis and Result

The uni-dimensionality, validity and reliability of the instrument have been tried by running a Factor Analysis. Additionally, an arrangement of the questionnaire containing the basic measurements of programming quality to demonstrate the execution level of the programming industry was given to the designers subsequent to refining the instrument.

The first step in this analysis ensures the construct validity of the questionnaire so that the Factor Analysis (FA) results were calculated according to the method of the basic components with the tilted rotation using SPSS V 22.0. The results were according to the following Table 4.1.

Table 4.1. Factor analysis of survey.

Exploratory Factor Analysis							**Confirmatoy Factor Analysis**		**Relibl -ity**
Factors	Numbr of items	Deter minans	Kaisr Meyr Olkin (KO)	Bartls Test	Extractn	Variane	CFI	BFI	Cronb ach's Alpha
LSS Benefis	7	0.010	0.771	0.000	0.834	52.767 13.408 12.529	0.934	0.927	0.859
LSS CSF	10	0.003	0.775	0.000	0.690	45.675 12.247 9.11	0.904	0.901	0.873
SDM Benefis	4	0.224	.0683	0.000	0.655	61.244	0.908	0.913	.0775
SDM CSF	4	0.684	.0653	0.000	0.721	27.152 20.571	0.913	0.906	0.701
Agile Benefs	6	0.061	.0774	0.000	0.701	48.357 18.391	0.915	0.912	0.820
Agile CSF	8	0.035	0.757	0.000	0.714	42.810 14.246 11.863	0.918	0.922	0.827

An alpha value of (0.70) or more is considered as strong consistency of established scales, the Cronbach's Alpha value shown in the Table 4.1 indicated all factors have reliability (0.7) very good internal consistency reliability for the scale with this sample.

To measure the self-correlation problem, the set value must be less than (0.0001) if it is

Its value is less than that we look at the variables associated with higher than (0.80) and delete them in the table indicates that all values of the determinants are greater than (0.5).

There are two main issues to consider in determining whether a particular dataset is suitable for factor analysis: sample size, and the strength of the relationship among the variables. Two statistical measures are generated by SPSS to help assess the factorability of the data Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. Bartlett's test less than (.0001) this means the sample size allow for analysis, in Table 4.1 indicated all the sig values = 0.000 and the KMO all the value more than (0.6) this means the data is valid for analysis.

This process of rotation must allow us to compiling variables of similar nature in one factor.

In the extraction matrix variables having low communalities -say lower than 0.40- don't contribute much to measuring the underlying factors.

The empirical load is used to evaluate the capacity of a model, the factors involved in the expression of the data set in the comparison between the models of factors in this field were using the 22 V AMOS software, the overall Comparative Fit Index (CFI) as well as Bentler Bonett Fit Index (BFI) values are above 0.90 for all the constructs. There by indicating strong

unidimensionality and convergent validity .

Fig 4.2, show the distribution of the research methodologies used by the survey participants in the software development projects and showed that Agile methodology and LSS are the most frequently used, the figure indicates that, 38% of participants stated that their organization does use Agile, 27% stated that their organization use LSS methodologies and 17%stated that their organization use SS methodologies. Whereas from participants, 18 % stated that their organization use more one methodology

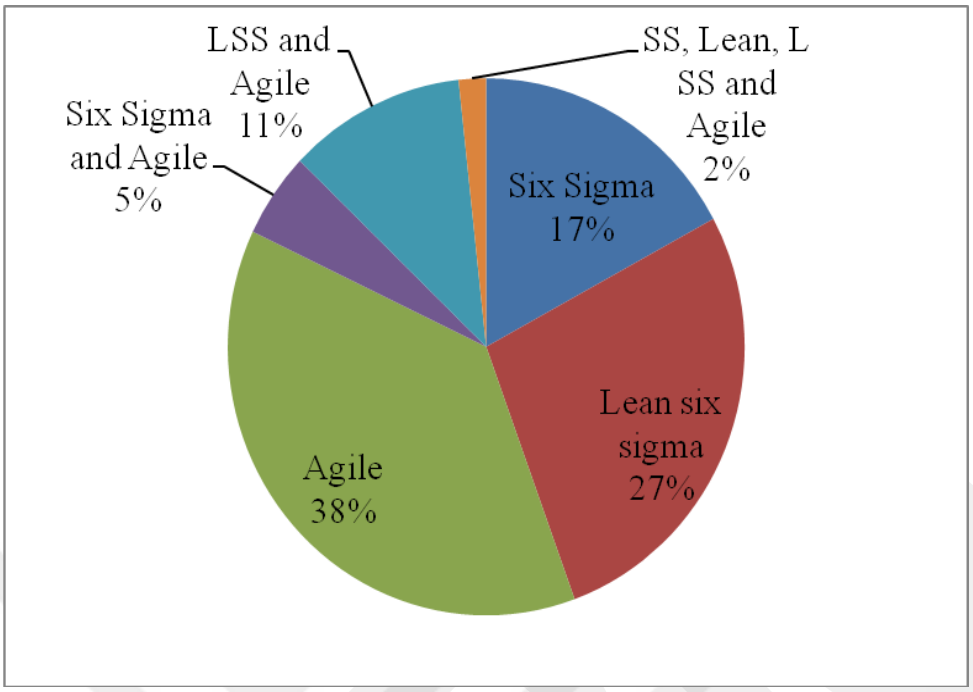

Figure 4.2. Survey participants and their use of research.

4.5.1.1 Lean and Six Sigma

Lean and Six Sigma is the way to provide tools for organizations to improve their operations, ultimately to reduce the disadvantages, improve production, and increase profits. In the present study, our attempt is focused on a number of concepts and principles within these methodologies and concepts, namely experiences, critical success factors, roles and benefits in the programming companies. These enable decision-makers to use these concepts as reference points, increase efforts to improve the overall operations, satisfy customers and emerge triumphant in competition with other firms in the industry. In light of this information, we form the hypotheses about the relationship between these concepts, their impact on each other, and the importance of this influence.

Hypotheses to be tested:

H0.1: There is no relationship between years of experience of SS and satisfaction with Six Sigma program. (Q9-Q14)

H0.2: There is no relationship between years of experience of Lean and satisfaction with Lean program. (Q10-Q5)

H0.3: There is no relationship between complexity level of project and satisfaction with SS program. (Q6-Q14)

H0.4: There is no relationship between complexity level of project and satisfaction with Lean program. (Q6-Q15)

H0.5: There is no relationship between selection criteria of tools of Lean and SS in number of projects implementation. (Q12-Q13)

H0.6: There is no relationship between the selection of tools and technical standards and satisfaction with SS program. (Q13-Q14)

H0.7: There is no relationship between the selection of tools and technical standards and satisfaction with Lean program. (Q13- Q15)

For analysis data collection we used SPSS 22 software. The tests of factor analysis Chi-square test were used for this purpose.

Table 4.2 indicated the result of the years of experience have effect on satisfaction in the implementations of Six Sigma within organizations. The team's experience gives Six Sigma methodology the ability to improve development results clearly and increase the volume of collaboration between teams and customers as well as the satisfaction of participation.

Table 4.2. Result on variation evaluate the satisfaction with the result obtined through Six Sigma with expeperience.

Cross tabulation		Years of experience					Chi-Square Tests
		<1 year	1-3 years	4-10 years	>10 years	Total	Sig
Satisfaction with the results obtained through SS program	Highly dissatisfied	0	3	1	0	4	.025
	Dissatisfied	0	0	2	0	2	
	Neutral	1	3	9	3	16	
	Satisfied	10	10	18	3	41	
	Highly satisfied	0	4	0	1	5	
	Total	11	21	31	7	70	

Table 4.3 indicated the result of the years of experience have no effect on satisfaction in the implementations of Lean methodology within organizations.

Table 4.3. Result on variation evaluate the satisfaction with the result obtined through Lean with expeperience.

Cross tabulation		Years of experience Total					Chi-Square Tests
		<1 year	1-3 years	4-10 years	>10 years	Total	Sig
Satisfaction with the results obtained through Lean program	Highly dissatisfied	0	1	0	0	1	.287
	Neutral	3	5	8	2	18	
	Satisfied	5	14	15	5	39	
	Highly satisfied	0	0	3	1	4	
	Total	8	20	26	8	62	

Table 4.4 indicated the result of the complexity level of projects has effect on satisfaction in the implementations of Six Sigma within organizations; SS methodologies have been widely used in medium and large-scale projects with satisfaction of performance. Venture management is a strategy or set of methods that can be connected to particular circumstances, as per the inborn idea of the

circumstance and cognizant decision; in this way, information and practices of project administration don't make a difference consistently to all projects [137].

Table 4.4. Result on variation complexity level of project and satisfaction with Six Sigma program.

Cross tabulation		Complexity level of the project				Chi-Square Tests
		low	Medium	High	Total	Sig
Satisfaction with the results obtained through SS program	Highly dissatisfied	0	3	1	4	.010
	Dissatisfied	0	2	0	2	
	Neutral	6	7	3	16	
	Satisfied	1	28	12	41	
	Highly satisfied	0	2	3	5	
	Total	7	42	19	68	

Table 4.5 indicated the result of the complexity level of projects was impact on satisfaction in Lean implementations. Lean methodologies have been widely used in medium and large-scale projects.

Table 4.5. Result on variation complexity level of project and satisfaction with Lean program.

Cross tabulation		Complexity level of the project				Chi-Square Tests
		low	Medium	High	Total	Sig
Satisfaction with the results obtained through Lean program	Highly dissatisfied	1	0	0	1	.004
	Neutral	5	12	4	21	
	Satisfied	1	29	12	42	
	Highly satisfied	0	2	3	5	
	Total	7	43	19	69	

Chi-Square result selection criteria of tools and technical with number of projects are given in Table 4.6. It has been observed that there exists significant in nature of

business and familiarity of project Leader/Black Belt with the set of tools and technique in projects number implementation. The relationship is not significant with suggestions from external consultant, nature of project and nature of collected data.

Table 4.6. Result selection citeria of tools and technical with number of projects.

Cross tabulation		Number of Project				Chi-Square Tests
Technical standards		Non	1-3 projects	More than 3 projects	Total	Sig
Nature of business	No	2	15	21	38	.025
	Yes	**7**	13	8	28	
	Total	9	28	29	66	
Suggestions from external consultant	No	9	22	22	53	.270
	Yes	0	6	7	13	
	Total	9	28	29	66	
Nature of project	No	7	12	16	35	.180
	Yes	2	16	13	31	
	Total	9	28	29	66	
Nature of collected data	No	5	17	16	38	.906
	Yes	4	11	13	28	
	Total	9	28	29	66	
Familiarity of Project Leader/Black Belt with the set of tools and technique	No	7	17	27	51	.003
	Yes	2	11	12	15	
	Total	9	28	39	66	

Table 4.7. Indicated the result of Selection criteria of tools and technical of Six Sigma have no effect on satisfaction in the implementations of Six Sigma within organizations, beyond Familiarity of Project Leader/Black Belt with the set of tools and technique was significant.

Table 4.7. Result on variation selection of tools and technical standards and satisfaction with Six Sigma.

Cross tabulation		Satisfaction with the results obtained through Six Sigma program						Chi-Square Tests
technical standards		Highly dissatisfied	Dissatis-fied	Neutral	Satisfied	Highly satisfied	Total	Sig
Nature of business	No	2	2	8	21	5	38	0.187
	Yes	2	0	8	20	0	30	
	Total	4	2	16	41	5	68	
Suggestions from externalconsultant	No	2	2	13	33	5	53	0.389
	Yes	2	0	3	8	0	15	
	Total	4	2	14	41	5	68	
Nature of project	No	4	2	10	18	1	35	0.053
	Yes	0	0	6	23	4	33	
	Total	4	2	16	41	5	68	
Nature of collected data	No	4	2	11	19	4	40	0.078
	Yes	0	0	5	22	1	28	
	Total	4	2	16	41	5	68	
Familiarity of Project Leader/Black Belt with the set of tools and techniqe	No	4	0	14	30	5	53	0.026
	Yes	0	2	2	11	0	13	
	Total	4	2	16	41	5	66	

Table 4.8. Indicated the result of selection criteria of tools and technical of Lean have on satisfaction in Lean implementations within organizations. Most respondents pointed out that the adoption of these techniques when using the Lean methodology is not intensive when the implementation of software development projects.

Table 4.8. Result on variation selection of tools and technical standards and satisfaction Lean methodology.

Cross tabulation		Satisfaction with the results obtained through Six Sigma program						Chi-Square Tests
		Highly dissatisfied	Dissatisfid	Neutral	Satisfid	Highly satisfied	Total	Sig
Nature of business	No	1	10	25	0	2	38	.555
	Yes	0	11	17	0	3	31	
	Total	1	21	42	0	5	69	
Suggestions from external consultant	No	0	16	34	0	5	55	.145
	Yes	1	5	8	0	0	14	
	Total	1	21	42	0	5	69	
Nature of project	No	1	11	21	0	2	35	.745
	Yes	0	10	21	0	3	34	
	Total	1	21	42	0	5	69	
Natureof collected data	No	1	13	23	0	3	40	.791
	Yes	0	8	19	0	2	29	
	Total	1	21	42	0	5	49	
Familiarityof Project Leader/Black Belt with the set of tools and technique	No	1	16	33	0	4	54	.952
	Yes	0	5	9	0	1	15	
	Total	1	21	42	0	5	69	

Abstract of analysis indicated that for the more or the less experience of software developers in the implementation of the Six Sigma within the companies that have been implemented has any effect on the satisfaction of performance in its implementation un like Lean methodology that has not had any effect on the satisfaction of performance in its implementation . It has also been shown that the

level of large or complex projects was related to the performance satisfaction of developers within the institutions, this complexity has affected the users of Lean and SS methodologies in development. Some influential criteria such as the nature of business and familiarity of project leader have been found in the number of projects implemented using these two methodologies. The nature of the selection of these standards has no relation to the satisfaction of the Six Sigma or Lean transactions within the organizations with exception Familiarity of Project Leader/Black Belt with the set of tools and technique.

4.5.1.2 LSS

LSS is an administrative approach focused on the team, and combines the methods of Six Sigma and manufacturing philosophy (Lean) In this study, the focus is mainly on this methodology and its role in the development of software, especially in recent years and within the present fields of software development concepts and standards that lead to success or failure in projects using LSS. In detail, the information sought will include the benefits of LSS implementation, Critical Success Factors, degree of satisfaction, experiences and problems faced when using LSS. The goal is to come up with conclusions leading to standards, their impact and relationships to help software developers to form accurate and high-quality products without waste of time or budget.

Hypotheses to be tested:

H0.8: There is no relationship between years of experience of LSS and satisfaction with LSS program. (Q6-Q20)

H0.9: There is no relationship between participated type of consultants in the planning and implementation of the LSS program and benefits of LSS implementations. (Q19-Q23)

H0.10: There is no relationship between stages of LSS implementation and benefits of LSS implementation. (Q18-Q23)

H0.11: There is no relationship between full time using LSS methodology expert and benefits of Lean Six Sigma implementations. (Q22-Q23)

H0.12: There is no significant correlation between knowledge of the LSS program and the problems facing the application of this program. (Q17-Q22)

H0.13: There is no significant impact to barriers that facing of LSS implementation in succsess software development projects. (Q21)

H0.14: There is no significant impact benefitis of LSS implementation in software development projects. (Q23)

H0.15: There is no significant impact to the critical success factors of LSS projects implementation. (Q24)

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Analysis and Result

For analysis data collection we used SPSS 22 software. The test of factor analysis Chi-square test, one-sample T Test and correlation were used for this purpose.

Table 4.9. Indicated the result of the years of experience have no effect on satisfaction in the implementations of Lean Six Sigma within organizations. Since the using LSS tools experience hinges on number and nature of project, understanding use of Lean Six Sigma tools and top management support that's where your focus should be. From process start to marketing, from operations to decisions, access to the satisfaction stage in the use of this methodology.

Table 4.9. Result on variation evalute the satisfaction with the results obtained through LSS program with years of experience.

Cross tabulation		years of experience					Chi-Square Tests
		<1 year	1 - 3 years	4 -10 years	>10 years	Total	Sig
satisfaction with the results obtained through Lean Six Sigma Program	Highly dissatisfied	0	3	0	0	3	.578
	Dissatisfied	1	2	0	1	4	
	Neutral	1	6	2	5	14	
	Satisfied	8	14	4	3	29	
	Highly satisfied	5	5	2	1	13	
	Total	15	30	8	10	61	

Table 4.10. Indicated the result of the participated type of consultants in the planning and implementation of the Lean Six Sigma program have no effect on benefits of LSS implementations within organizations. As we have seen, there is no need to use consultants external in software companies. This may be due to the number of experts within these companies, Software manufacturing is complex, it is not easy to implement.

Companies are seeking to attract the largest number of experts in this field before starting any development project. This property has a greater role in manufacturing than in software industry LSS counseling causes the ventures to diminish the variations in the items and process. The more in like manner advantages of including Six Sigma affirmation consulting company incorporate less imperfections, expanded limit, extreme quality, bring down cost, higher income, decreased capital consumption and shorter process duration [138].

Table 4.10. Result on variation benefits of LSS implementation particpated type of consultants.

Cross tabulation		Benefits of LSS						Chi-Square Tests
		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total	Sig
Participated by External Consultants of the LSS	No	3	4	10	10	5	32	.494
	Yes	1	1	11	4	4	21	
	Total	4	5	21	14	9	53	

Before embarking on any development process it is important to select the project and identify the obstacles to the development processes. LSS helps to select the right and timely projects through the DMAIC development stages and provide measurable results.

Table 4.11. Indicated the result of define, improve and control the stages of LSS have significant impact in benefits of implementation Lean Six Sigma: plan, measure and analysis this stages of which need attention in the organizations.

Table 4.11. Result on variation of LSS implementation with stage of LSS.

Cross tabulation		Satisfaction with the results obtained through Agile						Chi-Square Tests
		Highly disstron-gly	Disstrongly	Neutral	Strongly	Highly Strongly	Total	Sig
Plan	No	5	2	22	18	2	49	.530
	Yes	2	2	11	4	2	21	
	Total	2	2	29	33	0	70	
Define	No	0	2	26	24	4	56	. 015
	Yes	0	0	3	9	0	14	
	Total	0	2	29	33	4	70	
Measure	No	2	2	24	24	4	56	.520
	Yes	0	0	5	9	0	14	
	Total	2	2	29	33	4	70	
Analysis	No	2	2	27	31	4	66	.967
	Yes	2	2	0	0	0	4	
	Total	4	4	27	31	4	70	
Improve	No	4	8	17	17	7	53	.020
	Yes	0	0	15	6	2	17	
	Total	2	3	26	31	3	69	
Control	No	2	2	24	23	0	51	.008
	Yes	0	0	5	10	0	19	
	Total	2	3	26	31	3	70	

It is seen that from Table 4.12. Full time LSS expert have real relationship to the benefits of the institution in the implementation of LSS methodology implementations. Full Time is one of the biggest problems facing LSS applications in software companies.

Table 4.12. Ruslt on variation benefits of LSS implementation with time using LSS .

Cross tabulation		Full time LSS expert						Chi-Square Tests
		Non	1-2	3-4	5-6	6+	Total	Sig
Satisfaction with the results obtained through Lean Six Sigma Program	Highly dissatisfied	2	1	0	0	0	3	0.042
	Dissatisfied	0	0	1	3	0	4	
	Neutral	1	2	3	1	5	12	
	Satisfied	3	7	6	13	3	32	
	Highly satisfied	1	3	1	7	1	13	
	Total	7	13	11	24	9	64	

Correlation result knowledge of LSS program and barriers for implementation of Lean Six Sigma is given in Table 4.13. It has been observed that lack of team culture was result of lack knowledge of LSS methodology. Six-Sigma requires a great deal of aptitude with respect to experts to run extends viably [62]. LSS techniques need to be properly understood and applied within organizations to get the desired results, but LSS may fail in some cases due to some Lack of management commitment, Lack of project structure poor data collection and analysis, and lack of resource and documentation.

Table 4.13. The result between knoledge of LSS methodology and barriers for implementation of LSS.

Correlatio		Lack of management commitment	Lack of resource and documentation	Lack of project structure	Lack of team culture	Measurement problems	Poor data collection and analysis
knowledge of Lean Six Sigma methodology	Pearson Correlation	-.196	-.078	.015	-.418**	-.112	-.166
	Sig	.126	.549	.905	.001	.388	.196
	N	62	62	62	62	62	62

Barriers for Implementation of Lean Six Sigma

There are many barriers that can affect the application of the LSS which have made software manufacturing enterprises to be distrustful about the appropriateness of Six Sigma for them.

Table 4.14. Ruslt barriers that face implementation of LSS.

	Tests of Normality	Test Value = 3			
				95% Confidence Interval of the Difference	
One-Sample T test	Shapiro-Wilkt	df	Sig	Lower	Upper
Lack of management commitment	.254	65	.000	.40	.84
Lack of recourse and documentation	.219	65	.000	.41	.86
Lack of project structure	.241	65	.000	.41	.89
Lack of team culture	293	65	.000	.27	.67
Measurement problems	266	65	.050	.00	.45
Poor data collection and analysis	.220	65	.000	.70	1.11

It is clear from the results shown in Table 4.15 that the probability value (sig) t for all barriers that face implementation of LSS in study With the Shapiro-Wilk's test of normality, the null hypothesis associated assumes normality of the sample under consideration is larger than the level of 0.05. Thus, the distribution of data for these fields follows the natural distribution, then where the one sample T test were used to answer hypothesis.

The One-Sample Test result on variation of barriers that face implementation of LSS companies is given in Table 4.14. It has been observed that there exists significant effect problems faced in Lean Six Sigma implementation.

LSS Benefits

As LSS merges the benefits of both Lean and Six Sigma, it is able to deliver additional services when compared to using just one approach. Though many researchers have offered conflicting reports as to LSS benefits, there is a broader recognition that it is a commercial process development practice able to deliver fundamental advantages.

It is clear from the results shown in Table 4.15. That the probability value (sig) t for all benefits of LSS in study With the Shapiro-Wilk's test of normality, the null hypothesis associated assumes normality of the sample under consideration is larger than the level of 0.05. Thus, the distribution of data for these fields follows the natural distribution, then where the one sample T test were used to answer hypothesis.

Table 4.15. Ruslt LSS benefts.

	Tests of Normality	Test Value = 3			
				95% Confidence Interval of the Difference	
One-Sample T test	Shapiro-Wilk	df	Sig	Lower	Upper
LSS initiatives make significant part in successful of the projects.	. .227	65	.000	.21	.67
LSS improvements able to reduce costs significant and time	.217	65	.002	.14	.62
LSS has/had helped the organization to customer be more focused.	.261	65	.000	.40	.81
The organization has/had accomplished significant operational & financial gains from LSS initiatives	.234	65	.000	.41	.86
LSS gives you greater control over your work and easily for projects.	.325	65	.023	.04	.59
Employees thinks that LSS is work as one set of tools, techniques and practices to solve complex problems	.197	65	.228	-.10	.40
LSS helps you to develop high quality software	.274	65	.007	.10	.62
Minimization of waste/non-value added activities	.203	65	.000	.29	.68

The One-Sample Test result on variation of LSS benefits companies is given in Table 4.15. It has been observed that there exists significant effect benefits obtained in Lean Six Sigma implementation except for the employees made opinion LSS as an only set of tools, techniques and practices to solve problems that has not been realized through the organization.

CSFs

CSFs are thought to be amongst the furthermost and noteworthy aspects of excellence in supervising structural goals and purposes as well as operation process. CSFs are the elementary factors essential to be attained by the corporation or the areas that yield the utmost "inexpensive influence". It is commonly acknowledged that the aspects vital to achievement are not goals, but the actions and processes that can be measured by administrative and supervisory standards and in accordance to the aims. It is paramount to classify all the pressing issues and plans in such a way as to make innovation and upgrading possible and maintain success over the long-run.

It is clear from the results shown in Table 4.16. That the probability value (sig) by Shapiro-Wilk test for all success factors of LSS in study is larger than the level of 05.0. Thus, the distribution of data for these fields follows the natural distribution, then where the one sample T test were used to answer hypothesis.

Table 4.16 Ruslt CSFs impact.

	Tests of Normality	Test Value = 3			
				95% Confidence Interval of the Difference	
One-Sample T test	Shapiro-Wilk	df	Sig	Lower	Upper
Management Change Culture LSS (MCC)	.261	63	.583	-.20	.36
Organizational Infrastructure for LSS (OI)	.230	63	.011	.07	.55
Link to Business Strategy (LBS)	.213	62	.000	.21	.68
Support of Team Members(SOTM)	.258	63	.016	.07	.62
Effective and Understanding use of LSS tools	.226	63	.011	.09	.66
Effective Communication (EC)	.237	63	.046	.01	.56
Top Management Support and Involvement (TMSI)	.239	63	.066	-.02	.52
Customer Focus(CF)	.207	63	.000	.26	.80
Role of Information Technology(RIT)	.242	63	.244	-.10	.38
Use of External Consultants(EC)	.292	61	.357	-.15	.41
Training & Education on LSS (TE)	.231	62	.020	.05	.61

The One-Sample Test result on variation of success factors Lean Six Sigma companies is given in Table 4.16. It has been observed that there exist significant effect success factors Lean Six Sigma companies with respect to organizational infrastructure for Lean Six Sigma, link to business strategy, support of team members, effective and understanding use of Lean Six Sigma tools, effective communication, customer focus and training and education on Lean Six Sigma.

The effect is not significant with respect to management change culture for Lean Six Sigma, project management skills, role of information technology and use of

external consultants. Companies that use the LSS program to provide their employees with the culture of the company, which plays a role in achieving the objectives of the methodology, which prevents employees from returning to the old ways of development and senior management always has a degree of interest in the success of software development projects may be failure depends on the extent of experience and the correct use of tools.

The external consultant was not one of the active elements for the success of the operations LSS and this support is also based on the ninth hypothesis.

Abstract of analysis indicated that for the experience of software developers in the implementation of the Lean Six Sigma program within the companies that have been implemented has not had any effect on the satisfaction of performance in its implementation. The hypotheses that have been developed show us that the stages of definition, improve and control of LSS are the most prominent and most important stages of the implementation in the software industry.

The problems faced by LSS program have a clear impact on the obstruction of implementation. has been developed another imposition of knowledge to know whether the cause of these problems is the lack of full knowledge of the owners of the principles and concepts of this methodology and it had a clear impact shortage in the team while not full time impact on achieving the benefits of LSS execution.

LSS critical success factors in the software industry have a clear importance to the benefits of their implementation and the most important factors are the OL, LBS, SOTM, TE, CF, EU and EC that can be considered standard for achieving profitability, competitiveness and quality in the software industry.

4.5.1.3 SDM

Software development is the main problem under study. Successful projects are managed well for a project with efficiency and high quality. Accordingly, development teams put in their best work for the success of these projects. There are several methodologies for software development and the team is responsible for selecting the appropriate methodology to employ. We have devised a number of hypotheses about software development methodologies that would help software

developers to obtain a clear vision as to customers and their expectations. This will certainly help developers to satisfy their customers, stay competitive, and continue to develop.

Hypotheses to be tested:

H0.16: There is no relationship between years of experience of software development methodologies and benefits of SDM implementation. (Q26-32)
H0.17: There is no relationship between software methodologies used and benefits of SDM implementation. (Q27-Q32)
H0.18: There is no relationship between the scope of software development methodologies and benefits of SDM implementation. (Q28-32)
H0.19: There is no relationship between the type of project in which a company uses software development and benefits of SDM implementation. (Q29-32)
H0.20: There is no significant impact to the critical success factors of SDM projects implementation (Q31)

Analysis and Result

For analysis data collection we used SPSS 22 software. The tests of factor analysis Chi-square test, Independent Samples Test and one-sample T test were used for this purpose.

Table 4.17. Indicated the result of the company time involvement software development was effect on benefits of software development implementation; the years of experience have relationship in the implementations of SDM within organizations.

Table 4.17. The result and time involvement development with benefits of SDM.

Cross tabulation		Years of experience					Chi-Square Tests
		<1 year	1-3 years	4-10 years	>10 years	Total	Sig
Benefits of Software development methodologies	Disagree	0	1	1	0	2	.029
	Neutral	6	15	6	3	30	
	Agree	5	16	1	2	24	
	Strongly agree	0	3	0	8	11	
	Total	11	35	8	13	67	

Table 4.18. Indicated the result of the software development methodologies embedded in this segment, of which Agile, Waterfall, Test- Driven Development and Rapid Application Development have a significant impact on the benefits of software development.

Table 4.18. Result sortware methodologies used and benefits of SDM.

Cross tabulation		Benefits of SDM						Chi-Square Tests
		Strongly disagree	Disagr- ee	Neutral	Agree	Strongly agree	Total	Sig
SDM	Water Sluice	3	5	3	0	0	11	.000
	Waterfall	0	0	3	1	3	7	
	Test- Driven Developmnt	1	1	2	6	2	12	
	Agile	0	0	4	14	4	22	
	Rapid Application Developmnt	0	0	5	6	1	12	
	Own Made	0	0	2	0	0	2	
	Total	4	6	19	27	10	66	

Table 4.19 indicated the result of the company typically use software development methodologies in significant is development area, Software/System Analysis and Software /System Design, while use that methodology the less significant in requirement specifications and testing area.

Table 4.19. Result the scope of software development methodologies.

Cross tabulation		Satisfaction with the results obtained through Agile						Chi-Square Tests
		Highly disstrongy	Disstro-ngly	Neutral	Strongly	Highly Strongly	Total	Sig
Requirements specification	No	0	2	16	9	3	30	.112
	Yes	0	0	12	15	8	35	
	Total	0	2	28	24	11	65	
Develop-ment	No	4	4	11	9	2	30	. 014
	Yes	0	1	8	18	8	35	
	Total	0	2	29	33	4	65	
Testing	No	1	7	8	24	6	46	.110
	Yes	1	0	6	8	6	20	
	Total	2	2	29	33	4	66	
Software /System Analysis	No	4	6	16	22	4	52	.016
	Yes	0	0	3	5	6	14	
	Total	4	4	27	31	4	66	
Software /System Design	No	4	6	10	18	3	41	.022
	Yes	0	0	9	9	7	25	
	Total	4	6	19	27	10	66	

Table 4.20. Indicated the result of the type of projects in which a company uses software development was effect on benefits of software development implementation, multiple comparisons in type of projects satisfaction which mostly it have significant impact.

Table 4.20. Result type of project and benefits of software development implementation.

Cross tabulation		Benefits of SDM					Chi-Square Tests
		Disagree	Neutral	Agree	Strongly agree	Total	Sig
Type of project	Mostly un-structured	0	5	1	0	6	.000
	Structured Partially	1	18	22	0	41	
	Highly structured	1	8	1	9	19	
	Total	2	31	24	9	66	

It is clear from the results shown in Table 4.27 that the probability value (sig) by Shapiro-Wilk test for all success factors of SDM in study is larger than the level of 05.0. Thus, the distribution of data for these fields follows the natural distribution, then where the one sample T test were used to answer hypothesis.

The One-Sample Test result on variation of success factors software development methodology companies is given in Table 4.21. It has been observed that there exist significant effect success factors SDM companies except size of the organization or institution factor that no significant effect.

Table 4.21. Result CSFs impact.

	Tests of Normality	Test Value = 3			
				95% Confidence Interval of the Difference	
One-Sample T test	Shapiro-Wilk	df	Sig	Lower	Upper
Size of the organization or institution	.076	52	.718	-.26	.37
The nature of the activity of the organization	.225	52	.034	.02	.54
The degree of complexity of systems	.204	52	.017	.06	.61
Increasing resource succession of phases	.054	52	.000	.26	.76
Understanding the nature of the management of the development process	.222	52	.000	.46	1.05
The rapid development of information technology software and hardware	.094	52	.001	.17	.66

Abstract of analysis indicated that for the experience of software developers has had a significant impact on achieving many benefits in development methodologies. The results obtained indicate that all methodologies for the development of the studied software have had a significant impact on the benefits of development and the greatest impact of the methodologies was within the scope of development, software /system design and software/system analysis, the results obtained indicate that the benefits of software development are influenced by the type of project intended for you.

Critical success factors developed for all software development methodologies were clearly effective except for the Size of the organization or institution because the development methodologies were starting to focus on large companies but in recent years it has been used in small and medium enterprises and achieved the desired profitability and competitiveness.

4.5.1.4 ASD

ASD is a set of methodologies and skills based on values, principles, the development of programming solutions as an outcome of teams' collaboration, and the use of appropriate practices in a timely manner. In our study, a number of hypotheses related to the principles and values of Agile are constructed to study the interrelations between them and their effect on each other.

Hypotheses to be tested:

H0.21: There is no relationship between years of experience that have Agile users and satisfaction on the performance of the Agile methods. (Q35-Q39)

H0.22: There is no relationship between Agile methodology often used for Software development and satisfaction with performance of the Agile methods. (Q36-39)

H0.23: There is no relationship between knowledge of Agile methodologies and satisfaction with performance of the Agile methods. (Q38-39)

H0.24: There is no significant correlation between knowledge of the Agile program and the problems facing the application of this program. (38-40)

H0.25: There is no impact of the changes associated with Agile team on the clarity of project requirements. (Q41-42)

H0.26: There is no significant impact to the critical success factors of Agile projects implementation. (Q44)

Analysis and result

For analysis data collection we used SPSS 22 software. The test of factor analysis Chi-square test, Independent Samples Test, one-sample T Test and correlation were used for this purpose.

It is seen that from table 4.22. The years of experience have no effect on satisfaction in the implementations of Agile within organizations.

Table 4.22. Result on variation evalutes the satisfaction with the results obtained through Agile with years of experenice.

Cross tabulation		Years of experience					Chi-Square Tests
		<1 year	1-3 years	4-10 years	>10 years	Total	Sig
Satisfactin with the results obtained through Agile methods	Strongly dissatisfied	1	0	0	1	2	0.088
	Dissatisfied	0	2	0	1	3	
	Neutral	2	13	7	7	29	
	Satisfied	10	8	3	10	31	
	Strongly satisfied	1	0	2	0	3	
	Total	14	23	12	19	68	

Chi-Square tests result the Agile methodologies often used for Software development and satisfaction with performance of the Agile methods given in Table 4.23. It can be observed that there exist no significant effect from the Agile methodology on the satisfaction with its implementation, except in case of Adaptive Software Methodology and Extreme Programming, where the effect is significant.

Table 4.23. Result Agile methodologies often used for software and satisfaction with performance of Agile.

Cross tabulation		Satisfaction with the results obtained through Agile						Chi-Square Tests
		Highly dissatis-fied	Dissatisf-ied	Neutral	Satisfied	Highly satisfied	Total	Sig
Adaptive Software	No	2	2	19	17	2	43	.029
	Yes	0	0	7	14	1	22	
	Total	2	3	26	31	3	65	
Extreme Programming	No	1	3	11	25	1	41	. 018
	Yes	0	2	9	0	6	24	
	Total	1	21	42	24	3	65	

"Table 4.23 (cont'd)"

Scrum	No	3	2	21	24	0	53	.745
	Yes	0	0	5	7	3	12	
	Total	3	2	42	7	3	67	
Feature Driven Develop-ment	No	1	13	23	0	3	40	.791
	Yes	0	8	19	0	2	29	
	Total	1	21	42	0	5	49	
Crystal Method ologies	No	2	3	26	31	3	63	.952
	Yes	0	0	0	0	0	0	
	Total	2	3	26	31	3	69	
Combie more than one method	No	2	3	26	30	3	64	.051
	Yes	0	0	0	1	0	1	
	Total	2	3	26	31	3	65	

Table 4.24 indicated the result of the there is strong relationship between the satisfaction with the implementation of in Agile methodologies and the underlying knowledge of the elimination of such methodologies.

Table 4.24. Result between knowledge of Agile methodologies and satisfaction performance of the Agile methodology.

Cross tabulation		Knowledge of Agile methodologies						Chi-Square Tests
		Very limited	Limid	Avrage	Extens-ve	Very extensive	Total	Sig
Satisfaction with the results obtained through Agile	Strongly dissatisfied	1	0	1	0	0	2	.015
	Dissatisfied	2	0	1	0	0	3	
	Neutral	7	6	15	0	1	29	
	Satisfied	12	2	14	0	3	31	
	Strongly satisfied	0	1	1	1	0	3	
	Total	22	9	32	1	4	68	

Table 4.25 indicated the result of the lack of inherent knowledge about the methods and methodologies of Agile is causing some of the problems facing software developers is lack of project structure and lack of experience using Agile.

Table 4.25. Result between knowlge of Agile methodologies and problems that faced Agile implementaion.

Correlations		Rate knowlede of Agile methodol-ogies	Lack of recourse and documen tation	Lack of managemet commitment	Lack of team cultue	Lack of project structue	Lack of up-front planni-ng	Lack of Experience using Agile
Rate knowled ge of Agile methodol ogies	Pearson Correlat ion	1	-.146	-.044	.135	.396**	-.007	-.275*
	Sig		.265	.740	.303	.002	.956	.033
	N	60	60	60	60	60	60	60

Table 4.26 indicated the result of the clarity of project requirements has effect on changes associated with Agile team. Most user Agile development agree changes with Requirements defined and Requirements are well selected

Table 4.26. Result changes associated with Agile team on the clarity of project requirements.

Cross tabulation		Requirements of the projects available of Agile					Chi-Square Tests
		Require ments clearly defined	Require ments are well selected	Require ments fuzzy define	Requirem ents unclear and uncertain	Total	Sig
Agile team should stable visions be always subject to change	Disagre	0	2	1	0	3	.000
	Neutral	10	7	0	6	23	
	Agree	20	15	2	0	37	
	strongly agree	1	3	3	0	7	
	Total	31	27	6	6	70	

CSFs

Agile methodologies run out step-by-step with high expectations for delivery with quality and time. This means cooperation between teams for all processes that are under Agile project practices. It is successful among the cooperative teams led by this methodology. More importantly, the methodology works for one distributed system and may not work for another; this is due to the years of experience in project implementation by the teams and the success of the project. We have drawn a set of critical success factors based on best practices and lessons learned.

It is clear from the results shown in Table 4.27 that the probability value (sig) for all success factors of Agile in study With the Shapiro-Wilk's test of normality, the null hypothesis associated assumes normality of the sample under consideration is larger than the level of 0.05 ($p > 0.05$). Thus, the distribution of data for these fields follows the natural distribution, then where the one sample T test were used to answer hypothesis.

Table 4.27. Result CSFs impact.

	Tests of Normality	Test Value = 3			
				95% Confidence Interval of the Difference	
One-Sample T Test	Shapiro-Wilk	df	Sig	Lower	Upper
Project nature	.201	59	.600	-.23	.40
Management change culture	.059	58	.000	.21	.67
Teamwork	.203	58	.000	.41	.91
Customer focus	.241	58	.000	.31	.84
Use of Agile tools effective and understand	.212	58	.024	.05	.63
Good practice of Agile techniques	.258	58	.000	.38	.94
Top management support and involvement	.133	57	.000	.28	.79
Use of suitable Agile methods	.220	58	.048	.00	.54
Existing processes	.209	58	.007	.11	.67

The One-Sample Test result on the variation of success factors in Agile methodology is given in Table 4.27. It has been observed that there exist significant effects due to success factors of Agile methodology with respect to management change culture, use of Agile tools effective and understand support of team members, good practice of Agile techniques, top management support and involvement, customer focus, use of suitable Agile methods and existing processes. It can be stated that the effect is not significant with respect to project nature.

Abstract of analysis indicated that for the experience of software developers in the implementation of Agile program within the companies that have been implemented has not had any effect on the satisfaction of performance in its implementation. One of the hypotheses was that the lack of knowledge of the methodologies and concepts of Agile implementation of software development made the dissatisfaction with the results obtained within the organizations that were abstracted by the methodologies and also the lack of full knowledge about the concepts of these methodologies may cause in some of the barriers that hinder the implementation of operations, including lack of project structure and lack of experience using Agile, and the advantages of the methodology of the order that has been confirmed is that the changes associated with the team Agile always have a positive impact on the requirements of projects, which gives the method of methodology, flexibility, speed and availability with frequent changes to consumer requirements.

Agile critical success factors have had a significant impact on the progress of the software industry and all the factors have had an effective impact on that except for project nature, this may be due to the fact that previous studies proved that Agile is one of its advantages to deal with difficult and complicated projects.

4.5.1.5 Scrum

Scrum is one of the most flexible methodologies in software development and appropriate for it in the long-term with frequent changes to the requirements; it is also suitable for projects that require more than 300 hours of development [134]. Scrum has been selected from Agile as part of our study, and we propose a number of hypotheses related to concepts and effects of Scrum to help development teams to

learn about the extent of the relationship and influence that binds these concepts together.

Hypotheses to be tested:

H0.27: There is no relationship between type of projects a company uses Scrum on and level to which Scrum was used in that company.(Q47-49)

H0.28: There is no relationship between kind of Scrum project and implement it throughout the software development process. (Q48-Q51)

H0.29: There is no relationship between the kind of requirements used Scrum projects and implemented project type. (Q49-Q50)

Analysis and result

For analysis data collection we used SPSS 22 software. The tests of factor analysis Chi-square test were used for this purpose.

Table 4.28 indicated the result of the type of projects a company uses Scrum was impact on the level to which Scrum was used in that company. Every project type knows that selecting the right methodology is crucial to getting the level of Scrum was used in software companies right.

Table 4.28. Result on variation type of projects a company and level to which Scrum was used in that company.

Cross tabulation		Type of projects y used Scrum				Chi-Square Tests
		Mostly un-structud	Partially structurd	Highly structurd	Total	Sig
Level of Scrum	Hardly used at all	11	1	0	12	.000
	The use of parts of scrum methodology, but basically another way	1	8	4	13	
	Used conjunction with other methodologies	1	7	3	11	
	Completely	3	7	8	18	
	Total	16	23	15	54	

kinds of Scrum project on implement has been observed that there exist significant impact of kinds of (project hardly used at all) with other types of projects, we also see in Table 4.29 the kind of Scrum project on implement it was effect throughout the software development process.

Table 4.29. Result effect kinds of Scrum project on implementation it throughout the software development process.

Cross tabulation		Kind of software development projects						Chi-Square Tests
		None of the given answes	Complete softwae packag-es	Customer projet-ts	Sub-Systems componen ts or parts system	All kinds of software developme-nt projects	Total	Sig
Implement Scrum throughout the software development process	Complex kind of project	3	0	5	3	7	18	.004
	Projects that have strict deadlines	1	0	11	0	2	14	
	When we develop a program from scratch	1	1	0	1	8	11	
	Total	5	1	16	4	17	43	

Table 4.30 indicated the result of the kinds of requirements in implementation project type Scrum. It has been observed that there exists significant impact of changing requirements and the evolution of a lot during the project and big documents needs that will be ready at the beginning of the project; it is also an element that has an importance in interacting with the style of projects followed in the Scrum implementations.

Table 4.30. Result variation on the kind of requirements used Scrum projects in implementaion project type.

Cross tabulation		Type of projects your company used Scrumon				Chi-Square Tests
Kind of Requirements		Mostly un-structured	Partially structured	Highly structured	Total	Sig
Big documents needs that will be ready at the beginning of the project	No	3	10	10	23	.049
	Yes	11	13	5	29	
	Total	14	23	15	52	
Changing requirements and the evolution of a lot during the project	No	11	18	4	33	.002
	Yes	3	5	11	19	
	Total	14	23	15	52	
User Stories	No	3	10	10	23	.709
	Yes	11	13	5	29	
	Total	14	23	15	52	

Scrum Agile is significantly affected by changing requirements from customer and that evolution during a project implementation. It is also an element that has importance in terms of interacting with the style of the projects followed in Scrum implementations.

CHAPTER 5

RELATIONSHIP BETWEEN LEAN SIX SIGMA AND AGILE METHODOLOGY

5.1 Introduction

The Six Sigma and Lean frameworks have a comparable aim: they both intend to remove waste and make the most proficient framework conceivable. In any case, they embrace different approaches in the manner in which this goal is to be accomplished. In easiest terms, the essential differentiation among Lean and Six Sigma is that they perceive the hidden driver of waste in an unforeseen way. Lean experts attest that waste originates from pointless strides in the creation procedure that do not enhance the completed item; though Six Sigma advocates insist that waste is a result of the assortment inside the process itself. Obviously, there is truth in both of these evaluations, which is the reason both Lean and Six Sigma frameworks have been so compelling in improving general business execution in a wide range of fields. Actually, these two requests have ended up being especially productive when working in combine, consequently 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; Both 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 the software development process, process variations cannot be entirely eliminated, but effort has to be made in the

meantime to realize software development by empowering quick and adaptable reaction to such changes. In this respect, Lean Six Sigma has reduce process variations 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

5.2 Compare between Methodologies

There is a fine line of difference between Six Sigma, Lean, Lean Six Sigma and Agile as detailed in Table 5.1.

Table 5.1. Basis for comparisation in methodologies.

Method-ology	**SS**	**Lean**	**LSS**	**Agile**
Year of appearace	1980	1990	1986	1990 but applied it in early 2001
Definiton	Six Sigma is a dealt with and consider technique for imperative process change and new thing and management improvement .	Lean approach concentrates on examination and disposing of seven forms of waste through the entire procedure.	Lean Six Sigma is an administrative approach that consolidates Six Sigma techniques and apparatuses with lean assembling.	Agile is a gathering of programming advancement techniques that advance versatile arrangement, transformative advancement and conveyance, consistent change, and a period a fixed timeframe to finish an assemblage of work.
Aim	To satisfy customer requirements .	To enhance creation by expanding productivity all the while.	Fewer defects and decreased 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

5.3 Lean, Six Sigma with Agile

A set of techniques are utilized in Six Sigma for software development. In this respect, deploying quality in different functions becomes important and making agile development progress in operations even more so. In this way, the functions of the Six Sigma map are transferred in order to develop practical responses to project control issues. The results are valid for all types of lean software development

[109]. By doing so, one can 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, the general status of quality is improved and optimum results for clients in various projects are obtained [110].

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 with two prevalent Agile methodologies, Scrum and Extreme Programming [131].

When working Lean and Agile or both 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 [140].

When 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 [141].

5.3.1 Methodology

Agile is the originator and the most famous of its different branches in the world of software development, while Six Sigma and Lean emerge in the world of manufacturing and have only recently entered the world of software development. They are a major innovation and have had a role in the speed and effectiveness of development processes. For a comparison as to which one is the most effective and important in development of software, we formulate the hypotheses for testing. Implimentation

5.3.2 Hypotheses to be tested

H0.1: There is no significant difference between the Six Sigma, Lean and Agile methodologies implimentationin of size software development companies.

H0.2: There is no significant difference between the Six Sigma, Lean and Agile methodologies in high-profile software development projects.

H0.3: There is no significant difference between the satisfaction in companies that used Six Sigma in software development and the satisfaction in companies that used Agile.

H0.4: There is no significant difference between the satisfaction in companies that used Lean method in software development and the satisfaction in companies that used Agile.

H0.5: There is no significant difference between the experienced companies that used Six Sigma in software development and the experienced companies that used Agile.

H0.6: There is no significant difference between experienced companies that used Lean in software development and experienced companies that used Agile.

5.3.3 Analysis and Result

For the analysis of the data collected, we used the SPSS 22 software. The test of factor analysis Paired Samples Test One-Sample T Test, and Chi-square test were used for this purpose.

The emergence of the Six Sigma and Lean approaches is usually associated with large companies and, as a result of the lack of knowledge, training and misconception, SMEs have moved away from the adoption of Six Sigma. Hence, very few studies are available as to the application of the principles of Six Sigma in SMEs. However, as we can see in the Table 5.2, small and medium-sized companies have also started to adopt Six Sigma and Lean, and this is the case with the application of Agile methodology as the focus of its use is more appropriate in large companies. This analysis shows that the Six Sigma, Lean and Agile are easy-to-use in large and medium companies and more in use as opposed to small companies.

Table 5.2. Size of company.

Methodology	Size of company	Frequency	Percent	Valid Percent	Cumulative Percent
Agile	small	9	16.7	17.0	17.0
	Medium	25	52.1	53.2	70.2
	Large	13	29.2	29.8	100.0
Lean and Six Sigma	small	16	28.3	28.8	28.8
	Medium	19	35.8	36.5	65.4
	Large	17	34	34.6	100.0

Table 5.3. Size of company with Six Sigma, Lean and Agile methodology impact.

Chi-Square Tests	Value	df	Asymp. Sig.
Pearson Chi-Square	8.516[a]	4	.074
Likelihood Ratio	8.369	4	.079
Linear-by-Linear Association	.671	1	.413
N of Valid Cases	114		

Agile methodologies have been widely used in large-scale projects and which has helped the success of IT projects while their use in small-scale enterprise projects is lacking and may be due to the lack of a fixed method of managing small projects where they are perceived as easy to deploy to be given prioritization is low by the organization. In view of the Table 5.4. Agile methodology was used in large projects, more in small projects unlike in Six Sigma and Lean.

Table 5.4. Leval of project

Methodology	project	Frequency	Percent	Valid Percent	Cumulative Percent
Agile	low	3	6.3	6.5	6.5
	Medium	26	54.2	56.5	63.0
	High	17	35.4	37.0	100.0
Lean and Six Sigma	low	16	30.2	30.2	13.2
	Medium	30	56.6	56.6	69.8
	High	7	13.2	30.2	100

Table 5.5. Projects complexity with Six Sigma, Lean and Agile.

Chi-Square Tests	Value	df	Asymp. Sig.
Pearson Chi-Square	4.001[a]	4	.406
Likelihood Ratio	5.144	4	.273
Linear-by-Linear Association	.742	1	.389
N of Valid Cases	113		

Specific practices and impacts have a lot to do with satisfaction, and synergistic procedures are firmly associated with satisfaction, particularly when joined with specialized practices and a high consistency of satisfaction between Agile management and Agile developers [142].

Table 5.6 indecated of the results evaluate the degree of satisfaction with the results obtained using the Six Sigma approach and the satisfaction with the results obtained using the Agile methodology. In turn, the Independent Samples Test results assess the satisfaction with the Six Sigma program and Agile methodology. The results show that there exists a significant difference between Six Sigma satisfaction and Agile methodology satisfaction. From this hypothesis, we found that there is a positive relationship between the degrees of satisfaction in using both methodologies at the same time in software development.

Tble 5.6. Evaluation results of satisfaction with Six Sigma and Agile.

One-Sample T Test	Test Value = 3					
				Independet sample T test		
	t	df	Sig	Sig		
Satisfaction with the results obtained using Six Sigma program	5.675	61	.000	Satisfaction	Equal variances assumed	.033
Satisfaction with the results obtained using Agile methodology	4.162	57	.000		Equal variances not assumed	.032

Those who are interested in software development claim that one of the most important gains of the Lean and Agile methods is to make people more encouraged and satisfied with their employees, and that its most important priorities are to satisfy customers.

Table 5.7 indicated the result of evaluate the satisfaction with the results obtained using Six Sigma program and those obtained using the Agile methodology with a significant impact in companies. The Paired Samples Test result on the evaluation of the satisfaction between Lean program and Agile methodology reveals that there exists no significant effect between the level of satisfaction with Lean and Agile methodology.

Table 5.7. Evaluation result of satisfaction Lean with Agile.

	Test Value = 3			Pariedt sample T test		
	t	df	Sig			Sig
Satisfaction with the results obtained using Lean program.	8.658	64	.000	Satisfaction	Equal variances assumed	.139
Satisfaction with the results obtained using Agile program.	4.162	57	.000		variances not assume	.145

Each organization has a different development program based on the experience of the teams and their qualifications and willingness to practice the best business and in different ways. Table 5.8 shows the relationship between years of experience with Six Sigma program and that with Agile methodology. It has been observed that there is no significant effect difference between them.

Table 5.8. Result experience years of Six Sigma and Agile methodology.

Cross tabulation		Experience whit Agile				Chi- Square
		Less than 1year	1-3 years	4-10 years	More than 10years	Sig
Experience with Six Sigma	Less than year	0	3	0	0	.069
	1-3 years	0	1	1	3	
	4-10 years	2	2	0	2	
	More than 10 years	2	2	1	0	

The team's experience gives Agile methodology the ability to improve development results clearly and increase the volume of collaboration between teams and customers as well as the satisfaction of participation [143]. According to Table 5.9 the relationship between the experience years with Lean program and that with the Agile methodology has been observed to have no significant effect.

Table 5.9. Result experince years of Lean and Agile methodology.

Cross tabulation		Experience with Agile				Chi-Square
		Less than year	1-3 years	4-10 years	More than 10years	Sig
Experience years with Lean	Less than 1year	0	1	1	1	.397
	1-3 years	2	1	1	0	
	4-10 years	0	1	0	3	
	More than 10 years	0	2	3	1	

5.4 LSS with Agile

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 [7]. A coordination approach for Scrum and Lean Six Sigma is utilized as a part of genuine ventures to create programming customizations for cell phones. This approach empowers the 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 [144].

Applies Six Sigma approaches to software industry utilizing a hybrid simulation reproduction. It utilizes the generally gritty experimental data which the lean software development and Agile approaches create to reenact future activities. Such forecasts are utilized as the pattern estimation data to survey the genuine consequences of the persistent development activities [117].

Agile is one of the utilized practices among different other software development methodologies. Six Sigma and the Lean guidelines are thought to be prevalent quality apparatuses that guarantee the adequacy of value confirmation in the product advancement process. In this respect, presents a system that uses the highlights of Lean and Agile strategies to guarantee unrivaled software quality in a practical way [145].

5.4.1 Methodology

Our study is an attempt to combine two different approaches in manufacturing and software. We have developed a number of hypotheses with the purpose to understand the concepts, principles and success factors that combine LSS and Agile in the long-term to help us establish a basis for linking the two methodologies and to know the extent of the differences and similarities that combine them. With this in mind, the hypotheses are formed.

5.4.2 Hypotheses to be tested

H0.7: There is no significant difference between LSS methodology and Agile methodology with respect to barriers faced during implementation.
H0.8: There is no significant difference between LSS methodology and Agile methodology with respect to the benefits of implementation.
H0.9: There is no significant difference between LSS methodology and Agile methodology with respect to CSF.
H0.10: There is no significant difference between LSS methodology and Agile methodology with respect to the with respect to the previous and related experience gained by organizations using them.
H0.11: There is no significant difference between LSS methodology and Agile methodology with respect to the satisfaction in organization that used them for their software development initiatives.

5.4.3 Analysis and Result

For the analysis of the data collected, we used the SPSS 22 software. The test of factor analysis F-test, Paired Samples Test, One-Sample T Test, and Chi-square test were used for this purpose.

5.4.3.1 Relationship between Barriers for Implementation of LSS Methodology and Agile Methodology

As a result of the development of the world of technology in recent years many popular trends have been initiated; yet, in the meantime, these developments brought some companies face-to-face with problems, obstacles and challenges during the process of development. From Table 5.10 indecated of the common barriers facing implementation between LSS methodology and Agile methodologies.

Table 5.10. The most commn barriers of implemintation LSS with Agile.

LSS	Agile	LSS with Agile
• Lack of management commitment • Lack of resources and documentations • lack of project Structure • Lack of team culture • Measurement problems • Poor data collection & analysis	• Lack of management commitment • Lack of resources and documentations • lack of project Structure • Lack of team culture • Lack of up-front planning • Lack of Experience using Agile	• Lack of management commitment • Lack of resources and documentations • lack of project Structure • Lack of team culture

The F-test is used to determine whether there is any presence significant difference in the applications of barriers for Implementation between LSS methodology and Agile methodologies. The results show that, as in Table 5.11 in terms of the barriers for methodology implementation, no statistically significant differences exist between LSS and Agile methodology. Except lack of resources and documentation and lack of project structure, there is a significant difference between them.

Table 5.11. Barriers in implementation of LSS and Agile.

	LSS		Agile			
	Mean	Std. Deviation	Mean	Std. Deviation	F	sig
Lack of management commitment	3.62	.890	3.97	1.041	2.556	.114
Lack of resource and documentation	3.64	.905	4.05	.852	7.874	.008
Lack of project structure	3.65	.969	3.38	1.059	2.650	.016
Lack of team culture	3.47	.808	3.62	.958	1.355	.312

A comparison of the mean values of each barrier for implementation indicates that Agile methodology have more problems in lack of resource and documentation, cause more barriers in software development practice. Lack of project structure has the lowest value in the case of Agile methodology; it is the least significant barrier.

5.4.3.2 Relationship between Benefits of LSS Methodology and Agile Methodology

Any organization that needs customized programs or large-scale systems can benefit from the development of some methodologies to achieve profitability, competitiveness, quality and other desired benefits of its use in this field. From Table 5.12 idecated of the common benefits of implementation in case of LSS methodology and Agile methodology.

Table 5.12. Benefitis of LSS with Agile.

LSS	Agile	LSS with Agile
• Significant Part in successful of the projects. • To reduce costs significant and time • Help the organization to customer is more focused. • significant operational & financial • LSS gives greater control over work and ease of project development practices to solve problems • High quality • Minimization of waste/non-value added activities	• Flexibility in tasks • Significant Part in successful of the projects. • To reduce costs significant and time • Help the organization to customer is more focused. • Decreased the number of errors in the systems • Greater control over work and ease of project development • High quality	• Significant Part in successful of the projects. • To reduce costs significant and time • Help the organization to customer is more focused • Greater control over work and ease of project development • High quality

Again, the F-test is used to test whether there is any significant difference in the application benefits between the LSS methodology and Agile methodology. The results show, as they appear in Table 5.13, that there are statistically significant differences in terms of cost and time reduction, and greater and easy control over working projects. There is no a significant difference between other remaining benefits.

Table 5.13. Benefits of LSS and Agile methodology.

	LSS		Agile			
	Mean	Std. Deviation	Mean	Std. Deviation	F	sig
Significant projects success	3.44	.947	3.62	.885	.533	.670
Reduce costs and time significantly	3.38	.973	3.65	755	2.353	.016
Help the organization to focus more on customers	3.61	.820	3.65	.840	2.568	.113
Greater control over work and ease of project development	3.32	1.112	3.57	.789	2.353	.034
High quality	3.66	1.062	3.60	.718	.302	.820

A comparison of the mean values of the benefits associated with each methodology indicates that Agile methodology have better uses in some software development benefits like Reduce costs and time also Greater control over work and ease of project development .

5.4.3.3 Relationship between CSF of LSS Methodology and Agile Methodology

Software projects consume many resources during their development. However, not all projects are successful. Many factors have been suggested to contribute to the success or failure of projects which vary according to the approach or method of development. From Table 5.14 indecated of the common CSFs of LSS and Agile methodology.

Table 5.14. The most commn CSFs of LSS with Agile

LSS	Agile	LSS with Agile
• Management Change Culture for Lean Six Sigma(MCC) • Link to Business Strategy (LBS) • Organizational Infrastructure for Lean Six Sigma(OI) • Support of Team Members(SOTM) • Effective and Understanding use of Lean Six Sigma tools • Effective Communication (EC) • Top Management Support and Involvement (TMSI) • Customer Focus(CF) • Role of Information Technology(RIT) • Use of External Consultants(EC) • Training & Education on Lean Six Sigma	• Project nature • Management Change Culture • Teamwork • Customer focus • Effective and Understand use of Agile tools • Good practice of Agile techniques • Top management support and involvement • Use of suitable Agile methods • Existing processes	• Management Change Culture • Teamwork • Customer focus • Effective and Understand use of tools • Top management support and involvement

The F-test is used to determine whether there is any significant difference in the applications of CSFs between the LSS methodology and Agile methodologies. As in Table 5.15, the results show that, in terms of the CSFs, statistically significant differences exist in management change culture, teamwork , understanding and experience in using methodologies practices. There is no a significant difference between other remaining factors as customer, top management support and involvement.

Table 5.15. CSFs of LSS and Agile.

	LSS		Agile			
	Mean	Std. Deviatin	Mean	Std. Deviatin	F	sig
Management change culture	3.08	1.131	3.44	.896	2.986	.006
Teamwork	3.34	1.116	3.66	.958	2.750	.012
Customer	3.53	1.069	3.58	1.021	1.667	.250
Effective and understand use of tools	3.38	1.148	3.34	1.124	2.413	.042
Top management support and involvement	3.25	1.069	3.53	.977	.593	.637

Management change culture is an impact factor in the case of any organization. This is having higher mean in case of LSS and Agile. A comparison of the mean values of each factor (CSF) indicates that Agile methodology have better practices. Effective and understand use of tools and top management support and involvement have the lowest value in the case of Agile methodology.

Table 5.16. Indicated of the satisfaction with the outcomes of Lean Six Sigma program and compare them with those of Agile methodology, showing significant impact in companies. The Pariad Sample T Test results evaluate the satisfaction between Lean Six Sigma program and Agile methodology, indicating that there exists a significant effect between Lean satisfaction and Agile methodology satisfaction.

Table 5.16. LSS and Agile satisfaction result.

	Test Value = 3			Pariad Sample T Test		
	t	df	Sig			Sig
Satisfaction with Agile methodology	4.162	57	.000	Satisfaction	Equal variances assumed	.016
Satisfaction with LSS program	5.784	64	.000		Equal variances not assumed	.011

Experts using these methodologies are always more prone to facing challenges and have the most basic steps as effective and they are the most accommodating to the processes related to customers. It is seen from Table 5.17 that the relationship between years of experience with LSS program and Agile methodology is not significant at all.

Table 5.17. Result of experience years with LSSand Agile.

Cross tabulation		Experience years of LSS				Chi-Square
		Less than 1 year	1 - 3 years	4-10 years	More than 10years	Sig
Experience years of Agile methodology	Less than 1year	0	1	1	0	.155
	1-3 years	3	1	0	2	
	4-10 years	1	0	0	0	
	More than 10 years	0	3	0	1	

CHAPTER 6

THE COMPARE BETWEEN TURKISH COMPANIES AND CANADIAN COMPANIES IN SOME CONCEPTS RESPECT TO LSS AND AGILE METHODOLOGY

6.1 Introduction

In this study, most of the respondents were from software development companies in Turkey and Canada. We compared them with regard to LSS and Agile methodologies as the two have a big role in the software industry in both countries as Turkey and Canada have similar economic bases and a large population. The objective of the last part of the research is to determine whether or not software development in Turkey is no less important than in the world's largest software industry country.

6.1.1 Software Development in Turkey

The Turkish software development is considered youthful, dynamic, and developing. It presents motivations to be idealistic about the future; yet, meanwhile, it is experiencing obstacles and difficulties [146]. As indicated by a new Gartner report, Turkey is presently considered as one of the world's outsourcing goals since it has anchored its place in the list of the best 30 nations for Information Technology (IT), and offshore administrations. In the recent decade, the country has gained major ground in the software business, and this is reflected in the increase of its exports to numerous countries. Agile methodologies and utilization of various devices is becoming main stream in software development towards productivity. Lately, numerous product organizations have received CMMI level 3 to level 5 approvals. Because of these endeavors, Turkey’s software export has developed; still, the country needs to work in a maintained way towards higher ranks as an IT outsourcing country [147].

Turkey has a lively programming industry. Starting in 2011, there were around 1,600 software development companies in Turkey. The progressing difficulties of these firms in conveying ventures on time and on spending lead us to the scrutiny of the software engineering techniques and practices utilized in the industry. In reality, following legitimate and efficient software industry hones by all the software companies over the globe including Turkey is a noteworthy measure in deciding about the achievement or failure of software projects [148].

Many traditional software development methodologies believe that it is very useful such as: the effectiveness of requirements amassing and requirements essentials in a way that is imperative to a customer is frequently the most troublesome piece of software development for software development and it has numerous favorable circumstances, with the end goal that it gives quicker software development and enhances the capacity to deal with the changing prerequisites of clients. We have been using the traditional software development approaches (SDMs) for quite a while; yet, they have been shown to be too much blundering, making it difficult to meet the rapidly changing necessities and to have short thing life cycles. Another approach, which is as a rule extremely well known as of late, has arrived to meet these demands as is called Scrum.

Turkey is additionally influenced by this software development and numerous organizations need to execute this approach in order to have greater profitability and produce more proficient and powerful software items. Numerous software experts trust that it is extremely helpful for software development and it has numerous focal points, with the end goal that it gives speedier software development and enhances the capacity to deal with the changing prerequisites of clients [149].

As of late, numerous software industrial small and medium companies (SMEs) in Turkey have shown a tendency to adjust themselves with Agile methodologies over customary methodologies. Scrum and Kanban are two of the most utilized in Agile methodology as per an experimental investigation [150].

Software development is a complex issue, Scrum is difficult to execute and needs consideration and insight to explain these complex programming challenges. When

we consider the status of Scrum in Turkey, the outcomes are promising, not, best case scenario however. Given one of its pilot applications in Turkey, Overall Scrum is better. Likewise, numerous organizations like Scrum Turkey and Agile Turkey endeavor to adjust the Scrum in Turkey and need to utilize it in software development [149]. There are numerous deterrents and elements that debilitate the electiveness of the projects. This reality is considerably clearer in the weighty software industry, particularly in developing nations, for example, Turkey, where factual understanding isn't exceptionally normal and orderly methodologies are regularly disregarded. Feature some vital focuses that can add to the achievement and electiveness' of future six sigma programs by means of information got from various ventures information level of information based basic leadership , human factor and its administration are the most urgent factor for progress and culture of teamwork [151].

Implementation of SS globally has expanded the enthusiasm of different organizations. Because of this, the number of SS-applying projects in different nations is on the rise. By utilizing informative factor analysis, basic successes factors can be determined. As indicated by the outcomes, venture determination, quality culture and characterizing and estimating measurements are found to be the most important factors influencing success levels of SS ventures connected in Turkey [152]. Through the implementation of Six Sigma Benchmark approach in small and medium companies, essential factors valuable in setting the best system are determined for the Turkish Electric-electronic SME's in the country to become world-class producers in the long-run. These factors were data examination, quality outcomes, key arranging, client satisfaction, leadership, administration process quality, and human asset utilization [153].

6.1.2 Software Development in Canada

Canada is an advanced nation in software development. Canadian programming firms represent about 33% of the 250 biggest organizations in Canada, which has numerous exceedingly gifted software development experts with an expansive scope of ability and experience. Work costs for high value-added activities in Canada are

especially profitable when compared to the United States, Japan and Europe. Canada's profoundly talented software development experts, together with free access to the large U.S. software market, make Canada a perfect nearshore goal for software development [154].

Despite the fact that Canada appreciates a fortunate position as a country with one of the most standards of life in the world, it likewise faces various difficulties in its objective to remain all inclusive competitive. Canada's product industry is depicted alongside industry and government activities to enhance quality and competitiveness. Territories for concern incorporate deficiencies in administration ability and only fragile strengths in areas for example, innovative work end development or export orientation.

6.2 Methodology

The data for this thesis was collected from companies and used for the methodology. The comparison is made in some important aspects.
These are: the satisfaction of performance using these methodologies within the companies, the knowledge of the most important problems and barriers to the implementation of these approaches within the institutions, the benefits of their use and knowledge of the most important factors that lead to success in their implementation. The numbers of Turkish and Canadian companies in this study were 21 and 29, respectively. Number 1 is assigned as a symbol for the Turkish companies and number 2 for the Canadian companies in compare tables.
At this stage, we will look at a series of hypotheses to Satisfaction, Barriers to the Implementation of Methodologies, Benefits of Methodologies, CSF and Knowledge about methodologies.

6.2.1 Satisfaction

Employees taking an interest in Six Sigma feel positive changes in numerous parts of occupation satisfaction such as; develop personal and new skills and enjoy work [155].

Higher satisfaction is reported by those utilizing Agile development than with plan-driven procedures considering various points of view expressed by designers and those with an administrative post. There is also a high level of consistency in satisfaction between Agile engineers and Agile administration, whereas many contrasts are reported related to utilizing the practical plan-driven strategies [139]. Agile software development and Six Sigma both concentrate on satisfying the clients 'needs and share the same objective; both attempt to reduce failure rates and enhance consumer loyalty. The manner in which Agile software development ventures run is almost parallel with the way Six Sigma DMAIC approaches a project [69]

- ✓ H0.1: There is no significant difference between Turkish and Canadian companies with respect to satisfaction with using LSS in projects.

Table 6.1. Result related to satisfaction with LSS in Turkish and Canadian companies.

Independent Samples Test					Levene's Test for Equality of Variances		t-test for Equality of Means		
	Companies	N	Mean		F	Sig	t	df	Sig
Satisfaction with the results using LSS Program	1	32	3.66	Equal variances assumed	2.686	.106	-.502	66	.617
	2	36	3.78	Equal variances not assumed			-.495	57.994	.623

It can be observed m Table 6.1 that there exists no significant difference between Turkish companies and Canadian companies on the issue of satisfaction with applying the LSS methodology.

- ✓ H0.2: There is no significant difference between Turkish and Canadian companies with respect to the satisfaction with using Agile methodology.

Table 6.2. Result related to satisfaction with Agile application in Turkish and Canadian companies.

Independent Samples Test					Levene's Test for Equality of Variances		T-test for Equality of Means		
	Companies	N	Mean		F	Sig	t	df	Sig
Satisfaction with the results using Agile methodology	1	26	3.38	Equal variances assumed	1.332	.253	-.468	66	.642
	2	42	3.48	Equal variances not assumed			-.488	60.107	.627

It can be observed from Table 6.2 that there exists no significant difference between Turkish and Canadian companies in terms of satisfaction with Agile methodologies application**.**

6.2.2 Barriers for Implementation of Methodologies

Changing client requests, needs and expectations, increased levels of new innovations, and expanding rivalry among firms compel software development groups to create and afterward actualize new programming activities to satisfy their clients and lean toward commercial purposes. In this regard, an examination of such hindrances as to software development groups in Turkey, boundaries have been

found to be settled by building venture initiatives, making an information sharing society and considering team members' [156].

A vast majority of the organizations keen on Agile are those with numerous and extended involvement in traditional approaches. For moving to Agile methodology, they should then face up to the associated barriers and deterrents. The underlying foundations of the majority of such barriers are the prevalence of an authoritative culture and structures vital and common in traditional methodologies [60].

- ✓ H0.3: There is no significant difference between Turkish and Canadian companies with respect to the barriers for implementation of LSS.

Table 6.3. Result related to the barriers to the implementation of LSS between Turkish and Canadian companies.

Independent Samples Test					Levene's Test for Equality of Variances		t-test for Equality of Means		
	Companie-s	N	Mean		F	Sig	t	df	Sig
Lack of management commitment	1	32	3.78	Equal variances assumed	.553	.460	1.609	68	.112
	2	38	3.45	Equal variances not assumed			1.597	63.591	.115
Lack of recourse and documentation	1	32	3.63	Equal variances assumed	.016	.900	-.151	68	.880
	2	38	3.66	Equal variances not assumed			-.151	66.030	.880

"Table 6.3 (cont'd)"

Lack of project structure	1	32	3.72	Equal variances assumed	.095	.759	.259	68	.796
	2	38	3.66	Equal variances not assumed			.257	63.674	.798
Lack of team culture	1	32	3.28	Equal variances assumed	7.810	.007	-1.547	68	.126
	2	38	3.58	Equal variances not assumed			-1.596	65.625	.115
Measurement problems	1	32	3.22	Equal variances assumed	.045	.833	-.316	68	.753
	2	38	3.29	Equal variances not assumed			-.317	67.013	.752
Poor data collection and analysis	1	38	3.78	Equal variances assumed	3.909	.052	-1.115	68	.269
	2	32	4.00	Equal variances not assumed			-1.095	59.551	.278

It can be observed from Table 6.3 that there exists no significant difference between Turkish and Canadian companies as to the application barriers faced in LSS methodology.

- ✓ H0.4: There is no significant difference between Turkish and and Canadian companies with respect to the barriers for implementation of Agile.

Table 6.4. Result relatedto the barriers for implementation Agile in Turkish and Canadian companies.

Independent Samples Test					Levene's Test for Equality of Variances		t-test for Equality of Means		
	Companies	N	Mean		F	Sig	t	df	Sig
Lack of recourse and documentation	1	27	4.19	Equal variances assumed	3.355	.071	.872	69	.386
	2	44	4.00	Equal variances not assumed			.851	50.993	.398
Lack of management commitment	1	27	3.96	Equal variances assumed	.040	.843	.538	69	.592
	2	44	3.82	Equal variances not assumed			.547	57.928	.587
Lack of team culture	1	27	3.85	Equal variances assumed	.455	.502	2.429	69	.018
	2	44	3.30	Equal variances not assumed			2.459	57.308	.017
Lack of project structure	1	27	3.33	Equal variances assumed	.206	.651	-.482	69	.631
	2	44	3.45	Equal variances not assumed			-.495	59.585	.623

"Table 6.4 (cont'd)"

Lack of up-front planning	1	27	3.67	Equal variances assumed	.193	.662	.714	69	.478
	2	44	3.52	Equal variances not assumed			.669	44.367	.507
Lack of experience using agile	1	27	3.11	Equal variances assumed	.001	.980	-2.028	69	.046
	2	44	3.48	Equal variances not assumed			-1.913	45.408	.062

It can be observed from Table 6.4 that there exists no significant difference between companies in Turkey and Canada as to the applications barriers related to Agile methodology, except 'lack of team culture' and 'lack of experience using agile'. A comparison of the mean values of each barrier indicates that Turkish companies' lack of team culture is more than the Canadian companies, whereas lack of experience using agile is experience more in Canadian companies. This may be due to the selection of unsuitable team members that otherwise need necessary training, creativity and guidance all of which cannot be easy to carry out with team members who lack experience. Senior management and corporate heads often have the right to make decisions and identify innovations, in which circumstances Agile methodology requires a lot of training and practice given the amount of changes to which the organization is exposed [157].

6.2.3 Benefits of Methodologies

Lean Six Sigma systematic applications have many advantages and financial benefits for users that include quality, knowing about the actual sources of waste inside the company, having the privilege of preference, having more speed and less cost, and attaining better quality in improvement processes within companies [158].

The benefits gained in the application of Agile methodologies in software development, in turn, are satisfaction of customers, minimization of errors within the system, and adaptability to changes and requirements during the development process itself [159].

- ✓ H0.5: There is no significant difference between Turkish and Canadian companies with respect to the LSS benefits.

Table 6.5. Result related to the LSS benefits in Turkish and Canadian companies.

	Independent Samples Test				Levene's Test for Equality of Variances		t-test for Equality of Means		
	Compani-es	N	Mean		F	Sig	t	df	Sig
LSS initiatives make significant contribution to the success of projects.	1	32	3.38	Equal variances assumed	.270	.605	-.782	68	.437
	2	38	3.55	Equal variances not assumed			-.778	64.543	.439
LSS improvements reduce costs and time significantly.	1	32	3.16	Equal variances assumed	2.522	.117	-1.971	68	.050
	2	38	3.61	Equal variances not assumed			-2.004	67.975	.049
LSS has helped the organization to be more focused on customers.	1	32	3.47	Equal variances assumed	.263	.610	-1.511	68	.135
	2	38	3.76	Equal variances not assumed			-1.551	66.857	.126

"Table 6.5 (cont'd)"

The organization has achieved significant operational & financial gains with LSS initiatives.	1	32	3.72	Equal variances assumed	1.387	.243	.644	68	.522
	2	38	3.58	Equal variances not assumed			.658	67.491	.513
LSS offers greater control over work and can be applied for projects easily.	1	32	3.16	Equal variances assumed	2.378	.128	-1.390	68	.169
	2	38	3.53	Equal variances not assumed			-1.408	67.945	.164
Employees thinks that LSS is work as one set of tools, techniques and practices to solve complex problems.	1	32	2.88	Equal variances assumed	.031	.861	-2.369	68	.021
	2	38	3.42	Equal variances not assumed			-2.350	63.520	.022
LSS helps to develop high quality software	1	32	3.38	Equal variances assumed	1.246	.268	.026	68	.979
	2	38	3.37	Equal variances not assumed			.026	59.691	.980
LSS helps to minimize waste/non-value added activities	1	32	3.44	Equal variances assumed	6.635	.012	-.616	68	.540
	2	38	3.55	Equal variances not assumed			-.647	58.117	.520

Table 6.5 indecatid that there exists no significant difference between Turkish and Canadian companies in terms of LSS application benefits, except cost and time reduction and Employees thinks that LSS is work as one set of tools, techniques and practices to solve complex problems. A comparison of the mean values of each benefit indicates that Canadian companies have been able to reduce costs and time significantly by using LSS methodology more than Turkish companies. Also, LSS as a set of tools, techniques and practices to solve problems facing software developers was more agreed upon by Turkish companies' employees.

- ✓ H0.6: There is no significant difference between Turkey and Canadian companies with respect to the Agile benefits.

Table 6.6. Result related to the Agile benefits in Turkish and Canadian companies.

Independent Samples Test					Levene's Test for Equality of Variances		t-test for Equality of Means		
	Companies	N	Mean		F	Sig	t	df	Sig
Agile flexibility in tasks	1	26	3.73	Equal variances assumed	1.620	.207	1.392	68	.168
	2	44	3.36	Equal variances not assumed			1.472	61.646	.146
Agile has a significant contribution in the success of the projects	1	27	3.63	Equal variances assumed	2.280	.136	.472	69	.639
	2	44	3.52	Equal variances not assumed			.489	61.491	.626

"Table 6.6 (cont'd)"

Agile gives greater control over work and is easily used for projects	1	27	3.52	Equal variances assumed	.327	.569	.322	69	.749
	2	44	3.45	Equal variances not assumed			.323	56.073	.748
Agile has decreased the number of errors in the systems	1	27	3.81	Equal variances assumed	5.285	.025	1.546	69	.127
	2	44	3.43	Equal variances not assumed			1.712	68.836	.091
Agile has significantly reduced cost and time	1	27	3.74	Equal variances assumed	.378	.541	1.499	69	.138
	2	44	3.45	Equal variances not assumed			1.441	48.398	.156
Agile helps to create effective communicati on with customers.	1	27	3.78	Equal variances assumed	1.749	.190	1.499	69	.138
	2	44	3.43	Equal variances not assumed			1.620	67.120	.110
Agile helps to develop high quality software.	1	27	3.67	Equal variances assumed	.184	.669	-.080	69	.937
	2	44	3.68	Equal variances not assumed			-.080	54.388	.937

It can be observed that from Table 6.6 there exists no significant difference between Turkish companies and Canadian companies on the difference in the applications to the Agile benefits methodology Implementation.

6.2.4 CSFs of Methodologies

Given the growth rates in the software industry and the increased development of the software, there is a need to know the most substantial factors share in to the success of this development. All working projects are bolstered by Critical Success Factors, which are many and every venture requires a variety of CSFs to help the undertaking. For instance, the CSFs specific to certain enterprises can't be utilized as legitimate basic elements for other projects. The most well-known CSFs in software development projects are client inclusion, engagement of the top administration, specific objectives, client contribution, venture management and communication management [160].

In this study, we compare the success in the implementation of CSFs between Turkish and Canadian companies to test whether there is any significant difference in the applications of these CSFs between the two countries.

- ✓ H0.7: There is no significant difference between Turkish and Canadian companies with respect to the Critical Success Factors of Lean Six Sigma implementation.

Table 6.7. Result related to the Critical Succes Factors of LSS between Turkish and Canadian companies.

Independent Samples Test					Levene's Test for Equality of Variances		t-test for Equality of Means		
	Compani-es	N	Mean		F	Sig	t	df	Sig
Management Change Culture for LSS (MCC)	1	32	2.97	Equal variances assumed	2.189	.144	-2.113	66	.027
	2	36	3.28	Equal variances not assumed			-2.125	65.772	.026
Link to Business Strategy (LBS)	1	32	3.41	Equal variances assumed	2.485	.120	-.589	65	.558
	2	36	3.54	Equal variances not assumed			-.597	62.615	.553
Organizational Infrastructure LSS (OI)	1	32	3.22	Equal variances assumed	4.466	.038	-2.090	66	.028
	2	36	3.67	Equal variances not assumed			-2.110	63.771	.027
Support of Team Members (SOTM)	1	32	3.38	Equal variances assumed	.071	.790	.052	66	.959
	2	36	3.36	Equal variances not assumed			.052	64.147	.959

"Table 6.7 (cont'd)"

Effective and Understanding use of Lean Six Sigma tools	1	32	3.38	Equal variances assumed	.009	.924	-.150	66	.881
	2	36	3.42	Equal variances not assumed			-.150	64.685	.881
Effective Communication (EC)	1	32	3.16	Equal variances assumed	5.147	.027	-1.980	66	.331
	2	36	3.82	Equal variances not assumed			-1.993	65.186	.324
Top Management Support and Involvement (TMSI)	1	32	3.25	Equal variances assumed	1.308	.257	-.216	66	.829
	2	36	3.31	Equal variances not assumed			-.217	65.844	.829
Customer Focus(CF)	1	32	3.25	Equal variances assumed	.926	.339	-2.526	66	.014
	2	36	3.89	Equal variances not assumed			-2.550	65.892	.013
Role of Information Technology (RIT)	1	32	3.13	Equal variances assumed	.161	.690	-.060	66	.952
	2	36	3.14	Equal variances not assumed			-.060	65.349	.952
Use of External Consultants(EC)	1	32	3.22	Equal variances assumed	.421	.519	.694	64	.490
	2	34	3.03	Equal variances not assumed			.697	63.809	.488

"Table 6.7 (cont'd)"

Training & Education on Lean Six Sigma (TE)	1	32	3.41	assumed	.830	.366	.234	65	.816
	2	35	3.34	Equal variances not assumed			.236	64.698	.814

The CSFs related to LSS methodology use is given in Table 6.7, according to which there exists no significant difference between Turkish and Canadian companies with respect to link to business strategy, support of team members, effective and understanding use of lss tools, top management support and involvement, role of information technology, use of external consultants, effective communication and training & education on Lean Six Sigma. The difference is significant, though, with respect to management change culture, organizational infrastructure, and customer focus for LSS.

A comparison of the mean values of each CSF indicates that Canadian companies have more inclination toward management change culture, organizational infrastructure and customer focus for LSS their Turkish counterparts. The successful implementation of LSS requires a change both in the culture of the organization and that of staff, requiring behavioral adaptation among those within the organization so that they recognize the need for change.

The infrastructure of the organization requires a large amount of resources such as energy, costs, time, senior management, staff involvement and debt. As to the levels of expertise, they are divided to black belt, green belt, black belt master, Champions and others. Infrastructure change is a factor that is not easy to achieve in the software industry, where rapid change in common in the product requirements. Here, customer satisfaction is very important and diverts the focus toward designing products and systems in faster and shorter time to achieve that purpose.

- ✓ H0.8: There is no significant difference between the critical success factors (CSFs)in using Agile methodology between Turkish and Canadian companies.

Table 6.8. Result related the Critical Succes Factors Agile methodology application between Turkish and Canadian comanies.

Independent Samples Test					Levene's Test for Equality of Variances		t-test for Equality of Means		
	Compani-es	N	Mean		F	Sig	t	df	Sig
Project nature	1	27	3.15	Equal variances assumed	3.827	.054	.392	69	.697
	2	44	3.02	Equal variances not assumed			.421	66.482	.675
Managemen t change culture	1	27	3.48	Equal variances assumed	.700	.406	.024	67	.981
	2	44	3.48	Equal variances not assumed			.023	47.766	.982
Teamwork	1	27	3.74	Equal variances assumed	5.094	.027	.694	67	.490
	2	44	3.57	Equal variances not assumed			.739	65.324	.463
Customer focus	1	27	3.59	Equal variances assumed	1.748	.191	.254	67	.801
	2	44	3.52	Equal variances not assumed			.261	60.760	.795
Effective and understandi ng use of Agile tools	1	27	3.70	Equal variances assumed	2.120	.150	2.439	67	.017
	2	44	3.00	Equal variances not assumed			2.572	64.303	.012
Good practice of Agile techniques	1	27	3.74	Equal variances assumed	.694	.408	2.022	67	.310
	2	44	3.45	Equal variances not assumed			2.061	62.116	.290

"Table 6.8 (cont'd)"

Top management support and involvement	1	27	3.54	Equal variances assumed	4.711	.034	-.515	66	.609
	2	44	3.67	Equal variances not assumed			-.468	38.521	.642
Use of suitable Agile methods	1	27	3.48	Equal variances assumed	.129	.720	1.801	67	.076
	2	44	3.00	Equal variances not assumed			1.820	57.588	.074
Existing processes	1	27	3.07	Equal variances assumed	4.327	.041	2.424	67	.018
	2	44	3.74	Equal variances not assumed			2.661	67.000	.010

The CSFs of Agile methodology are given in Table 6.8, where it can be seen that there exist significant differences between the success factors in the Turkish and Canadian companies with respect to project nature, management change culture, teamwork, customer focus, and good practice of agile techniques, use of suitable agile methods and top management support and involvement. Yet, the difference is significant with respect to the use of agile tools and existing processes.

A comparison of the mean values of each CSF in Agile methodology Implementation indicates that Canadian companies focused on implement the existing processes more in developing by Agile methodology more than the Turkish companies. While understanding and experience in using methodologies practices in Turkish companies appears more than the Canadians, thereby confirming the result that we have obtained in the table on the experience of software developers with Agile methodology and tools in Turkish companies.

The Agile approach contains information about the process of managing basic configurations, how to meet the needs, project management, the way of communication, and commitment to customers. Understanding the use of Agile methodology, in this eve in, allows the team to plan and implement the work and

choose the appropriate methods for maintaining quality while facilitating the work of the team and adapting to the changes that occur during the development process.

6.2.5 Awareness about Agile Methodologies

As per Version One's State of Agile Report, starting in 2017, 94% of organizations practice Agile in some form. In any case, respondents report that such an attitude is not as common across the management board in their organizations, which implies that there is yet a long way to go as far as adoption and development are concerned [161].

- ✓ H0.9: There is no significant difference between Turkish and Canadian companies with respect to their knowledge of Agile methodology.

Table 6.9. Result related the knowledge of Agile methodology in Turkish and Canadian companies.

Independent Samples Test					Levene's Test for Equality of Variances		t-test for Equality of Means		
	Companies	N	Mean		F	Sig	t	df	Sig
Rate level knowledge of Agile method-logies	1	27	2.74	Equal variances assumed	3.526	.065	2.075	69	.042
	2	44	2.18	Equal variances not assumed			2.134	60.007	.037

Table 6.9 indicated that there exists significant difference between Turkish and Canadian companies as to the knowledge of Agile methodology implementation. A comparison of the mean values of each benefit indicates that Turkish companies have a higher rate of knowledge related to Agile methodology implementation than the Canadian companies.

CHAPTER7

DISCUSSION AND CONCLUSION

7.1 Discussion

A discussion of the hypotheses, by referring to the results in the tables in Chapters 4, 5 and 6, involves the following points:

- Experienced software developers (more or less experienced) have had little impact on performance satisfaction using Lean, Six Sigma, LSS and Agile methodology within the companies executing them.
- The stages of definition, improvement and control of LSS are the most prominent and most important stages of the implementation in the software industry.
- Lack of collaboration and networking in the LSS team is the main reason for the challenges facing the LSS implementation in software development organizations.
- All methodologies for the development of the studied software have a significant impact on the benefits of development. The greatest impact of the methodologies was within the scope of development, software/system design, and software/system analysis.
- The lack of knowledge of the methodologies and concepts of Agile implementation in software development made probably led to the dissatisfaction with the results obtained within the organizations that were abstracted by the methodologies. Also, the lack of thorough knowledge about the concepts of these methodologies may cause some of the barriers that hinder the implementation of operations, including lack of project structure and lack of experience using Agile.
- Scrum Agile is significantly affected by changing requirements from customer and that evolution during a project implementation. It is also an element that

has importance in terms of interacting with the style of the projects followed in Scrum implementations. The most common methods used in the development of Agile are ‘testing adaptive software’ and ‘extreme programming’, which may explain why we have received a few users of Scrum, this may be due to the fact that the Scrum framework cannot be used in large teams and teams that have no experience and difficulty in implementing quality principles when applied it.

- The Six Sigma, Lean and Agile are easier to use in large and medium companies compared to small ones.
- Agile methodology is used in large projects more than in small projects, unlike Lean and SS
- Lack of resources, documentation and project structure are the main problems faced by LSS and Agile implementation in software development.
- The ability to ‘reduce costs and significant time’, ‘greater control over work’ and ‘ease-of-use’in project implementation are the most important benefits obtained by software developers from the implementation of LSS and Agile methodology in the same project.
- ‘Management change culture’, ‘teamwork’, and ‘effective and understanding use of methodologies’ tools’ are essential for success in any software development project applying LSS and Agile.
- There is a significant difference between the Lean, Six Sigma, Lean Six Sigma and Agile methodology with respect to the satisfaction in companies implementing them.
- There were no significant differences between the Turkish and Canadian companies in several aspects such as: the total satisfaction with the results obtained from the use of LSS and Agile study methodology, the sum of the barriers and problems that to face LSS application and the benefits obtained from the implementation of Agile methodology.
- In Turkish companies, the problem facing Agile developers was ‘lack of team culture’, different from the Canadian companies where the biggest problem was ‘lack of experience using Agile’.
- Management change culture, organizational infrastructure and customer focus these are the success factors used in the LSS implementations which the

difference was evident in the software development between the Turkish and Canadian companies, while use of Agile tools effective and understand and existing processes are the factors affecting the success of Agile implementation which also differed in Turkish and Canadian companies.

7.2 Conclusion

The rapid development of information and communication technology in various fields has increased the need for software development, which is not easy to accomplish because it is a complex process that requires a lot of effort and there are difficulties achieving the factors that help organizations in doing so. Other criteria include quality, cost and quick delivery, and faster, easier, and more efficient and accurate operations. Managing software development projects entails using software development methodologies, and each organization performs its projects in different ways.

LSS is a hybrid system between Six Sigma and Lean intended to make all the productive factors work effectively. It is a data-based methodology to remove defects in manufacturing and increase profits for organizations. It eliminates the variances and defects in the product affecting customer satisfaction negatively. In turn, Agile is a framework for software engineering projects characterized by flexibility and a repetitive approach that helps development teams accomplish their tasks in a faster, less difficult, better, and naturally-responsive manner.

Agile is characterized by a focus on people and communication, while LSS centers around processes and tools, which makes the entire process of development integrated and achieves many benefits. In this research, an attempt was made to integrate the two methodologies, one of which is based on manufacturing and quality management and the other on software development.

Combining the stages of implementation in each of them leads to the completion of the development process in a faster, easier, more flexible, less expensive and higher-quality manner. Effort is also made in this study to determine the most important concepts and factors related to some methodologies in software development, such as Six Sigma, Lean, Lean Six Sigma, Agile and Scrum and the interrelationships between these concepts which may help developers to narrow down the factors that

help to the success and failure of the development process when using these methodologies.

Due to the importance of some of the experimental studies on the importance of Six Sigma entering the world of software development, and as a result of the major similarity between the principles of Lean and Agile, there is a need for the integration of these methodologies as referred to in previous studies on the subject. With this background, the present study was an attempt to identify the similarities and differences between Lean and Agile to highlight the desired importance of their interdependence.

The major developments witnessed by Turkey during the last ten years, especially in the field of software development, has turned it into one of the most competing countries in the world related with the industry. To prove this point was part of the study in the form of a comparison between a number of Turkish companies and Canadian companies specializing in this field.

This study attempted to provide a practical and intensive look at how to structure methodology concepts and to understand the interrelations among the software development institutions, specifically to assess the success and progress of the Lean, Six Sigma and Agile organizations, by:

- Introducing a model that combines the operational stages of the methodologies to try and adopt a new approach called (LSS-Agile) methodology;
- Identifying some of the concepts and principles of Six Sigma and Lean in the software industry and the relationships that connect them and influence each other in order to help researchers and developers to infer the strengths and weaknesses of the methodologies in development;
- Formulating hypotheses related to methodologies implemented in the software industry to help practitioners better understand related issues;
- Identifying some of the concepts and practices of Scrum found mainly for development;
- Highlighting the problems faced by Agile and LSS in the software development and find common issues faced by both;
- Determining the benefits that developers can gain from the LSS and Agile implementations and learning about the common and complementary gains, for

example, the flexibility and speed of Scrum Agileandquality management in Six Sigma;

- Identifying critical success factors (CSFs) related to two methodologies (Agile and LSS) and what is more important in the process of development, in addition to learning about common CSFs as studied and identified through the literature.
- Asserting that Turkish companies in the software development sector have entered the world market and become one of the most competitive countries in this field, which is no less important than any other software-producing country and is clear in our study compared with Canadian companies, which is the first competitor of US, Japan and EU companies.

7.3 Limitations of Study

When considering the results, we note that there are some restrictions in the survey that must be taken into account. In essence, some of the hypotheses were rejected and had no impact or relationship with their subject matters despite the anticipated importance attached to them, possibly due to the following:

- Differences in views among the respondents within the organizations;
- The difference in the method of training and implementation of LSS and Agile program between the companies;
- Focus in this study being on the specific roles within the companies (department heads, software developers);
- Questionnaires developed being based on previous studies in this field, while there may be reasons and other factors in reality that have not been codified;
- Answers being of arbitrary nature and not meditated thoroughly enough, in turn affecting the results obtained.

Another point is that, in essence, software development is not always a standard framework and it can have special specifications and focal points [162]. Also, given the time limits, the number of people participated in the study was relatively small, 115 respondents, whereas more than 350 questionnaires were sent out to about 59 companies.

7.4 Scope for Future Work

One of the ways in which it can theoretically be considered in the future is to try to integrate the stages of implementation of the Agile methodology with the LSS design methodology DMADV or DFSS to obtain a new proposed model. Furthermore, in practice, the focus should be on the software companies used for LSS and Agile together, which often gives more accurate results in terms of integration and comparison between the two.

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APPENDIX

This research study contributes towards the requirements for a PhD degree at Atilim University in Ankara, Turkey

Research Topic: Integrating Lean Six Sigma with Agile Software Development Methodology

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Dear Sir/Madam,

Completing this questionnaire should require less than 20 minutes. We plan to use the results of this survey to provide new insights on implementing Lean Six Sigma and Agile software development in enterprises like yours. For this purpose, please complete all of the questions in this questionnaire. All information will be kept confidential. There are three sections of this questionnaire; please complete Section A and either Section B or Section C. Please answer each question in every section. If the answer is not accurate, please give the best approximation instead of leaving empty answers.

- **Section A. Organization Characteristics.** Please **a**nswer questions 1-7.
- **Section B. Lean Six Sigma. [Ba]** Please answer Questions 8-14, which are general questions about Six Sigma and Lean methodologies. **[Bb]** Questions 15-24 are specific to the Lean Six Sigma methodology.
- **Section C. Software development methodology. [Ca]** Please answer Questions 25-32 in relation to the software development with which you were involved. **[Cb**] Questions 33-43 are general questions relating to agile methodology; please answer these questions if you used it. **[Cc]** If you used Scrum agile methodology, please answer Questions 43-50.

Which of the following methodologies have been used in software development?

☐ Lean ☐ Six Sigma ☐ Lean Six Sigma ☐ Agile

☐ Lean and Agile ☐ Six Sigma and Agile ☐ Lean Six Sigma and Agile

☐ Lean, Six Sigma and Agile ☐ Lean, Lean Six Sigma and Agile

☐ Lean, Six Sigma, Lean Six Sigma and Agile

_____

Section A. Organization Characteristics

1. What is the size of your company?

☐ Large Size Company ☐ Medium Size Company ☐Small Size Company

2. How long have you been working with your present employer?

☐<1 year ☐ 1 to 3years ☐ 4 to 10 years ☐>10years

3. Which of the following describes your position at the company?

☐ Programmer / Software Developer Analyst

☐ Consultant

☐ Architect Software Engineer

☐ Project Manager

☐ Other (please specify); _____

4. What types of applications do you develop in your company?

☐ Management information systems (e.g. decision support)

☐ Transaction processing systems (e.g. payroll, accounting, inventory)

☐ Real time applications (e.g. process control, manufacturing)

☐ E-commerce/web-based systems/web applications

☐ Embedded systems (e.g. software running in consumer devices or vehicles)

☐ Multimedia systems

☐ Other (please specify): _____

5. What kind of company is it?

☐ Software development ☐ Manufacturing ☐ Health

☐ Wholesale/Retail Trade ☐ Consulting ☐ Education

☐ Banking/Finance/Insurance ☐ Central Government ☐ System software

☐ Public Service/Local Government ☐ Telecommunications

☐Other (please specify): _____

6. What is the complexity level of the project?

☐ High ☐ Medium ☐ Low

7. What number of software users are employed by your company?

☐ Less than 10 ☐ Full time 10 to 20

☐ Full time 21 to 50 ☐ Full time 51 to 99

☐ Full time 100 to 300 ☐ Full time > 300

☐ Other (please specify): _____

Section B. Lean Six sigma (LSS)

- **Please complete this section only if your company either used or is currently using Six Sigma methods; otherwise, please go to section C, and start with question 38.**

- Questions 8-15 are general about Six Sigma and lean methodology.
- Questions 16-24 are specific to the Lean Six Sigma methodology.

[Ba] Lean and Six Sigma

8. What is your role in the company in terms of the Six Sigma project?

☐ Senior Manager ☐ Financial Controller ☐ Finance Team

☐ Six Sigma Leader ☐Black Belt (BB) ☐Green Belt (GB)

☐Other (please specify): _____

9. How many years has the company been using Six Sigma?

☐ Less than 1 year ☐ 1-3years ☐ 4-10years ☐ More than 10 years

10. How many years has the company been using Lean?

☐ Less than 1 year ☐ 1-3years ☐ 4-10years ☐ More than 10 years

11. Does your organization use any other process methodologies?

☐ Yes (please specify): _____

☐ No ☐ Don't Know

12. **How many projects have you tried or participated in so far, if any?**

☐ Non ☐ 1-3 projects ☐ More than 3 projects

13. **Please indicate the selection of tools and technical standards.** ***(You may choose more than one option*****).**

☐ Nature of business ☐ Suggestions from external consultant

☐ Nature of project ☐ Nature of collected data

☐ Familiarity of Project Leader/Black Belt with the set of tools and technique

☐Others (please specify) : _____

14. How does the company rate satisfaction with the results obtained through the Six Sigma Program?

☐ Highly satisfied ☐ Satisfied ☐Neutral

☐ Dissatisfied ☐ Highly dissatisfied

15. How does the company rate satisfaction with the results obtained through the Lean Six Sigma Program?

☐ Highly satisfied ☐ Satisfied ☐Neutral

☐ Dissatisfied ☐ Highly dissatisfied

[Bb] LSS

16. Number of years your organization was/has been using the Lean Six Sigma (LSS) methodology?

☐ Less than 1 year ☐ 1-3years ☐ 4-10years ☐ More than 10 years

17. Do the operators have knowledge about Lean Six Sigma??

☐ Yes ☐ No

18. Which stage is your organization in with the Lean Six Sigma program?

☐ Planning ☐ Define ☐ Measure

☐ Analyze ☐ Improve ☐ Control

19. Participated by External Consultants in the Planning and Implementation of the Lean Six Sigma?

☐ Yes ☐ No

20. How does the company evaluate the satisfaction with the results obtained through Lean Six Sigma Program?

☐ Highly satisfied ☐ Satisfied ☐Neutral

☐ Dissatisfied ☐ Highly dissatisfied

21. This question attempts to identify the type of implementation problems were experienced within Lean Six Sigma Program. Please rate them in order of their significance, on a scale from 1 (has the least impact) to 5 (has the most impact).

problems	Impact Level				
	1	2	3	4	5
Lack of management commitment					
Lack of resources and documentations					
lack of project Structure					
Lack of team culture					
Measurement problems					
Poor data collection & analysis					
Other, please specify) :					

22. Number of dedicated full time LSS experts (Black Belt/Master Black Belt) at your organization:

☐ 1 -2 ☐ 3 – 4 ☐ 5 – 6 ☐ 6+ ☐ None

23. This question attempts to identify the benefits of Lean Six Sigma implementation. Please indicate the extent to which you agree/disagree with the following (on a scale of Strongly Disagree - Strongly Agree).

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
LSS initiatives were a significant part of making the projects successful.	☐	☐	☐	☐	☐
LSS improvements were able to reduce costs and time significantly.	☐	☐	☐	☐	☐
LSS has/had helped the organization to be more focused on customers.	☐	☐	☐	☐	☐
The organization has/had achieved significant operational and financial profits from LSS initiatives.	☐	☐	☐	☐	☐
LSS gives you greater control over your work and enhances ease with projects.	☐	☐	☐	☐	☐
Employees thinks that LSS is work as one set of tools, techniques and practices to solve complex problems.	☐	☐	☐	☐	☐
LSS helps you to develop high quality software tools	☐	☐	☐	☐	☐
LSS helps with a minimization of waste non-value added activities	☐	☐	☐	☐	☐

24. This question attempts to identify the success factors, based on your Lean Six Sigma implementation experience. Please rate them in order of their significance, on a scale from 1 (has the least impact) to 5 (has the most impact).

Success Factors	Impact Level				
	1	2	3	4	5
Management Change Culture for Lean Six Sigma(MCC)					
Link to Business Strategy (LBS)					
Organizational Infrastructure for Lean Six Sigma(OI)					
Support of Team Members(SOTM)					
Effective and Knowledgeable use of Lean Six Sigma tools					
Effective Communication (EC)					
Top Management Support and Involvement (TMSI)					
Customer Focus(CF)					
Role of Information Technology(RIT)					
Use of External Consultants(EC)					
Training & Education on Lean Six Sigma(TE)					
Any others, please specify					

25. Please add any other comments relating to LSS methodology if you like:

_____)

_____)

_____)

Section C. Software Development Methodologies

- Questions 26-34 relate to software development with which you were involved. Questions 35-44 are general questions relating to agile methods. Please answer these questions if you used them. Also if you used the Scrum Agile methodology, please answer Questions 45-53.

[Ca] Software development

26. For how many years has the company been involved with software development?

☐ <1 year ☐ 1-3 years ☐ 4-10 years ☐ >10 years

27. Which software methodologies has your company used?

☐ Waterfall ☐ Water Sluice ☐ Test- Driven Development
☐ Agile ☐ Rapid Application Development
☐ Others (please specify): _____

28. In which of the following does your company typically use software development methodologies?

☐ Requirement specifications ☐ Development ☐ Testing
☐ Software/System Analysis ☐ Software /System Design
☐ Others (please specify): _____

29. Which statement best describes the type of projects your company is involved in?

☐ Highly structured ☐ Partially Structured ☐ Mostly unstructured

30. How well, in your opinion, does a software development methodology agree with the need for change of our methods?

☐ Very well ☐Quite well ☐ Adequately
☐ Quite poorly ☐ Very poorly

31. This question attempts to identify the success factor for software development, please rate, in order of their significance, in a scale from 1 (has the least impact) to 5 (has the most impact):

Success Factors	Impact Level				
	1	2	3	4	5
Size of the organization or institution					
The nature of the activity of the organization					
The degree of complexity of systems					
Increasing resource succession of phases					
Understanding the nature of the management of the development process					

32. This question attempts to identify the benefits of Software Development Methodologies (SDM) implementation. Please indicate the extent to which you agree/disagree with the following (on a scale of Strongly Disagree - Strongly Agree).

	Strongly Disagree	Disagree	Neutral	Agree	strongly agree
SDM helps you to understand your customers.	☐	☐	☐	☐	☐
SDM helps you to develop high quality softwares.	☐	☐	☐	☐	☐
SDM supports you in faster development	☐	☐	☐	☐	☐
SDM was more valuable than comprehensive documentation.	☐	☐	☐	☐	☐

33. Does the company use any other methodologies or Agile methodologies for different types of software development?

☐ Yes (please specify): _____

☐ No

34. Please add any other comments relating to software development methodologies:

_____)
_____)

[Cb] Agile methodology

35. For how long has your company has been using Agile?

☐ <1 year ☐ 1-3 years ☐ 4-10 y ☐ >10 years

36. Which Agile methodology do you often use for different types of Software development? *Please specify if more than one.*

☐ Adaptive Software ☐ Extreme Programming

☐ Scrum ☐ Feature Driven Development

☐ Crystal Methodologies ☐ Rational Unified Process

☐ Combine more than one method (please specify):

☐ Other (please specify): _____

37. Which Agile tools does your company use? ***Please specify if more than one.***

☐ Scrum Desk ☐ Scrum'd ☐ Scrum works
☐ MS Project ☐ Mingle ☐ Spreadsheets
☐ Physical wall and paper ☐ XPlanner ☐ explain PMT
☐ Other (please specify): _____

38. How would you rate your knowledge of Agile methodologies?

☐ Very Limited ☐ Limited ☐ Average
☐ Extensive ☐ Very extensive

39. Please indicate your company's satisfaction level with the Agile methods used by your company.

☐ Strongly satisfied ☐ Satisfied ☐ Neutral ☐ Dissatisfied
☐ Strongly dissatisfied

40. This question attempts to identify the type of implementation problems were experienced within Agile method. Please rate them in order of their significance, on a scale from 1 (has the least impact) to 5 (has the most impact).

problems	Impact Level				
	1	2	3	4	5
Lack of management commitment					
Lack of resources and documentations					
lack of project tructure					
Lack of team culture					
Lack of up-front planning					
Lack of experience using Agile					
Other, please specify) :					

41. When you are working with Agile team, should stable visions always be subject to change?

☐ Strongly agree ☐ Agree ☐ Neutral
☐ Disagree ☐ Strongly disagree

42. Which of the following describes the level of clarity in the requirements of the projects available in Agile? ***Please specify if more than one.***

☐ Requirements are clearly defined ☐ Requirements are well-selected

☐ Requirements are fuzzy ☐ Requirements are unclear and uncertain

43. This question attempts to identify the benefits of Agile implementation. Please indicate the extent to which you agree/disagree with the following (on a scale of Strongly Disagree - Strongly agree).

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Agile provides flexibility in tasks	☐	☐	☐	☐	☐
Agile has a significant contribution in the success of the projects	☐	☐	☐	☐	☐
Agile gives greater control over work and is easily used for projects	☐	☐	☐	☐	☐
Agile has decreased the number of errors in the systems	☐	☐	☐	☐	☐
Agile has significantly reduced cost and time	☐	☐	☐	☐	☐
Agile helps to create effective communication with customers	☐	☐	☐	☐	☐
Agile helps to develop high quality software.	☐	☐	☐	☐	☐

44. This question attempts to identify the success factors for software development. Please rate, the factors in order of their significance, on a scale from 1 (has the least impact) to 5 (has the most impact):

Success Factors	Impact Level				
	1	2	3	4	5
Project nature					
Management change culture					
Teamwork					
Customer focus					
Use of Agile tools effective and understood					
Good practice of Agile techniques					
Top management support and involvement					
Use of suitable Agile methods					
Existing processes					
Any others, please specify:					

[Cc] Scrum methodology

45. For how long has your company has been using Scrum?

☐<1 year ☐ 1-3 years ☐ 4-10 years ☐>10 years

46. What is your role in the company in terms of the Scrum project?

☐ Product Owner ☐ Scrum Master ☐ Team Member

47. Which of the following best describes the level to which Scrum was used in your company? *Please specify if more than one.*

☐ Completely

☐ Used in conjunction with other methodologies

☐ Used part of the scrum methodology, but basically used another way

☐ Hardly used at all

48. Do you think the company can implement Scrum throughout the software development process? *Please specify if more than one.*

☐ Complex kind of project ☐ Projects that have strict deadlines

☐ When we develop a program from scratch

49. Which statement best describes the type of projects on which your company used Scrum?

☐Highly structured ☐Partially structured ☐Mostly unstructured

50. What kind of requirements do you use Scrum for?

☐ Big documents needs that will be ready at the beginning of the project

☐ Changing requirements and significant evolution during the project

☐ User Stories

☐ Others (please specify): _____

51. What kind of software development projects can be implemented by the Scrum project management framework? *Please specify if more than one.*

☐ Complete software packages ☐ Customer projects

☐ Sub-Systems components or parts of systems

☐ All kinds of software development projects

☐ None of the given answers

52. What Scrum-agile practices does your company use? Please also mark the effectiveness of the used practices, on a scale from 1 (not effective) to 5 (extremely effective).

Scrum Practices	Impact Level				
	1	2	3	4	5
Planning Game					
User story					
Simply design					
Sprint					
Iterative					
Product Backlog					
Effort Estimation					
Collective ownership					
Daily Scrum meeting					
Continuous integration					

53. Any other comments relating to Scrum agile development method you like to add?

_____)

Thank you for your participation.Your assistance is greatly appreciated!