DOKUZ EYLÜL UNIVERSITY
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MASTER'S THESIS

LEAN SOFTWARE IN BUSINESS INFORMATION SYSTEMS

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DECLARATION

I hereby declare that this master's thesis titled as "Lean Software in Business Information Systems" has been written by myself in accordance with the academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resources in the reference list. I verify all these with my honour.

……./01/2017

Elif SUNAY

ABSTRACT

Master's Thesis

Lean Software in Business Information Systems

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The study aims to reveal the architecture of a process to ensure effective management of the software development process and integrate necessary tools into that architecture in order to improve processes.

Today, many business processes are managed via software. Due to the requirements in this context is dynamic and increasing acceleration of technological development, software is updated with a very short time and is replaced completely in some cases. The company that develops software to adapt the dynamism and manage the changes can only be possible by analyzing and improving the processes effectively and monitoring the performances continuously. Identification of the software development processes can be achieved by reference architecture and models; with analyzing and eliminating value-added activities and conditions, in the process of reaching to targeted software from targeted time and qualification, can be utilized from lean thinking principles and techniques.

Keywords: Lean Techniques, Software Development Process, Value Stream Mapping.

ÖZET

Yüksek Lisans Tezi
İşletme Bilişim Sistemlerinde Yalın Yazılım

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Dokuz Eylül Üniversitesi
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Çalışmanın amacı, yazılım geliştirme süreçlerinin etkin yönetimini sağlayacak bir süreç mimarisi ortaya koymak ve süreçlerin iyileştirilmesi için gerekli araçları bu mimari içerisine bütünleştirmektir.

Günümüzde pek çok iş süreci yazılımlar üzerinden yönetilmektedir. Bu kapsamdaki gereksinimlerin dinamik olması ve teknolojik gelişimlerin artan ivmesi nedeniyle yazılımlar çok kısa zaman aralıkları ile güncellenmekte; bazı durumlarda tamamen değiştirilmektedir. Yazılım geliştiren işletmelerin bu dinamizme uyum sağlayabilmesi ve değişimi yönetebilmesi ancak süreçlerinin etkin bir şekilde analiz edilmesi, geliştirilmesi ve süreç performanslarının sürekli izlenmesi ile mümkün olabilmektedir. Yazılım geliştirme süreçlerinin tanımlanması referans mimari ve modeller ile sağlanabilmekte; analiz edilmesi ve değer katmayan faaliyet ve koşulların ortadan kaldırılması ile hedeflenen yazılıma, hedeflenen zaman ve nitelikte ulaşılması aşamasında yalın düşünce ilkelerinden ve tekniklerinden yararlanılabilmektedir.

Anahtar Kelimeler: Yalın Teknikler, Yazılım Geliştirme Süreci, Değer Akış Haritalama.

LEAN SOFTWARE IN BUSINESS INFORMATION SYSTEMS

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ABBREVIATIONS

IT	Information Technology
XP	Extreme Programming
FDD	Future Driven Development
DSDM	Dynamic System Programming
MSF	Microsoft Solution Framework
ERP	Enterprise Resource Planning
CRM	Customer Relationship Management
WIP	Work In Progress
CU	Capacity Utilization
SOA	Software Oriented Architecture
SAAS	Software As A Service
IMVP	International Motor Vehicle Program
FORE	Feature-Oriented Requirements Engineering
HER	Electronic Health Record
RICE	Rapid Improvement Capacity Expansion
CSF's	Critical Success Factors

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INTRODUCTION

The concept of lean thinking in the process of producing goods and services aimed at the destruction of loss having regard to the concept of value from raw materials to delivery of products and services. The concept of Lean thinking aims that the value to be streamed at minimal downtime and it will reach to the ultimate customer in fastest way. Lean software provides effective management of the process of applying the concept of software processes.

The application of Lean thinking principles and techniques firstly began in the manufacturing sector and, with the observation of the created value-added, has spread out rapidly to service sector. Studies to be done in this context on the process of software development in the international studies indicate a growing tendency. At the first stage in the application of Lean Thinking, with using the technique of 'value map stream', will advise to reveal current value stream and will provide to be determined the activities do not create value. Lean techniques such as Kanban, 5S, SMED etc. will be added depending on the nature of the improvement points. Simulation and data mining techniques will be utilized for efficient analysis of potential improvements which will be done. By combining improvement phase based on lean thinking principles and the process architecture model, aim to reveal an integrated and reference model which will have a guide qualification that will include guidance to software developers about how to effect improvement on necessary points and how to effectively manage their processes. It will be planned to make a pilot application in order to present potential advantage and how to model can be performed.

Individual entrepreneurship in software sector is widespread; the firms are established as small-scale at least in the initial phase. In general, software projects are often carried out as a team; different fields of expertise can be utilized for the phase of application, design and analysis. Especially in small-scale firms, there is only one team, the process and resource management become difficult with the arriving of concurrent project.

Despite the uncertainty and strict conditions in the relevant market, in order to be survival with a sustainable structure, will be expected to help to provide cost-competitive advantage; in this context the thesis is considered to create a socio-economic benefit.

CHAPTER ONE
SOFTWARE DEVELOPMENT

1.1.   BASIC CONCEPT OF SOFTWARE DEVELOPMENT

Software development contains some processes that are related to writing and maintaining data. It is a process of developing software. The process should include some phases that have to be done successfully. It is generally agreed today that process of software development contains two important things: Actual writing of code and the preparation of requirements and objectives. What I mean is that the design of what is to be coded, and what is to be developed. It is important to emphasize that businesses should clarify objectives that has to be met.

Today, businesses can develop software for many purposes. Specific needs or specific client may be defined. They can decide according to the businesses to develop software. Furthermore, software may be developed for personal use. It aims to help software engineers. Personal software process provides them better understanding of code. It helps software engineers to improve their estimating and planning skills. They can manage the quality of their projects that helps to eliminate defects in their work. To sum up, software development includes new development, research, prototyping, modification (Personal software process, 2015, Software development, 2015, Learn IT Software development, 2015).

Typical phases of software development include;
(1) Identification of required software
(2) Analysis of the software requirements
(3) Detailed specification of the software requirements
(4) Software Design
(5) Programming
(6) Testing
(7) Maintenance

The existing system should be examined, deficiencies, which businesses have, should be determined. After determining, the new system requirements are defined. There, of course, are deficiencies that cause the process slow down. The businesses should be addressed for their improvements.

When new system is ready, old system starts to perish (Terzi and Atmaca, 2015, Learn IT Software development, 2015).

1.2.   QUALITY IN SOFTWARE DEVELOPMENT

Quality is able to answer customer needs. There are many internal and external factors influencing quality.

Internal factors in the organization:

(1)   Management

(2)   Human performance

(3)   Motivation of employees

(4)   Supplies

(5)   Machinery

(6)   Manufacturing methods

(7)   Instruments and devices of measurement

External factors in the organization:

(1)   Characteristics of customers

(2)   Condition of market

(3)   Financial sources

(4)   Technology (Kalite, 2015)

When we search about the meaning of quality, we would face many definitions. However, quality is to be best, as usual. In the broader sense, quality can be defined as degree of expediency.

When it is mentioned about quality in software development, it is inevitable to not to see perceived integrity and conceptual integrity. Perceived integrity can be defined as the relation between form and the surrounding context.

On the other side, conceptual integrity can be defined as the relation between form and function. Shortly, conceptual integrity is related to internal architecture of an application, while perceived integrity to its customer-facing side. We should take into account that every customer has a very different idea about quality experience. Quality has to adapt changing expectations of different type of consumers. Each customer will have different expectations.

Agile software may be defined in many ways. Some researchers argue that the term denotes to create a options that let decision to be postponed till the customer needs are more clearly identified. This is commonly understood to mean that agile approaches are unplanned. It is important to emphasize that confusing situations would be solved by plans. So, plans are able to respond to change. In agile and lean software development, one of the most important goals is to be able to answer customer needs (Berander and Damm, 2005). *Software quality attributes and trade-offs* (Blekinge Institute of Technology, The Architecture Tradeoff Analysis Method, 2015, Poppendieck, 2016, Wohlinh, 2016).

CHAPTER TWO
NEW TRENDS IN SOFTWARE DEVELOPMENT

2.1. NEW TRENDS IN SOFTWARE DEVELOPMENT

The question, whether it is important to keep up with current technologies in the changing world of software development, has been preoccupying the experts for some time. It is extremely important for sure. Methodologies and trends change. Business should be informed with all changes. They should follow them. Taking a glance at latest trends of software development techniques would be in place and beneficial for us to strengthen our knowledge on the mentioned subject (Poppendieck and Poppendieck, 2015).

Figure 1: Latest Trends
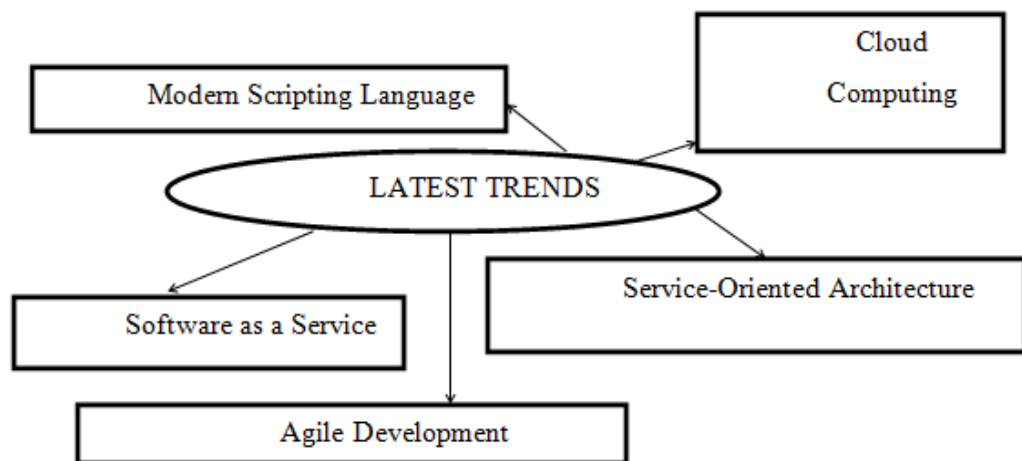
Source: Poppendieck and Poppendieck, 2015

2.1.1. Agile Development

Using Agile Software Development gives multiple opportunities to businesses. Client should be involved in all processes. It would give businesses an opportunity to have excellent customer relations (Software Development Trends and Perspectives, 2015, 8 Benefits of Agile Software Development Segue Technologies, 2015).

Figure 2: Agile Development Life Cycle
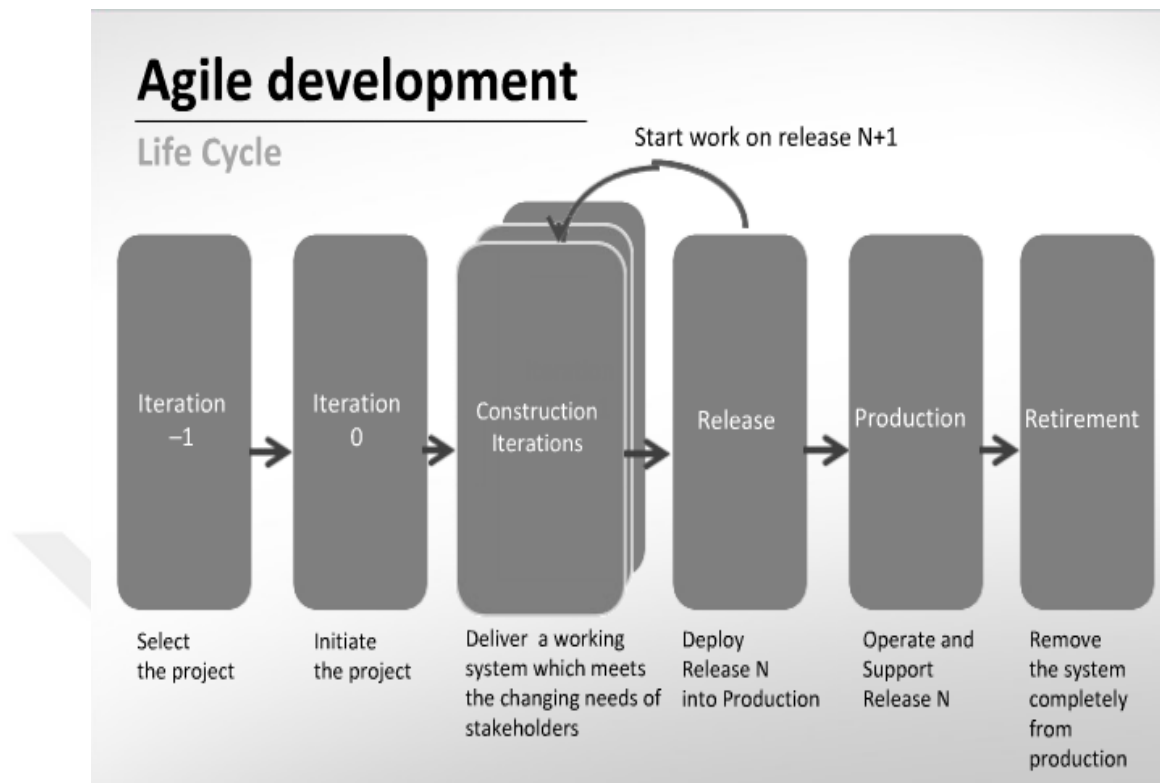
Source: Software Development Trends and Perspectives, 2015

Figure 2 is showing the Agile Developmet Life Cycle. What we usually have in mind when we talk about agile software development is to understand client vision. When software services are delivered to customers earlier or on time, it will cause to increase businesses' trust. So, businesses' focus should be on encourages their team to be more deeply engaged in their software projects.

Businesses may be use time-boxed in order to schedule their work time. Using time – boxed gives them opportunity to be aware of imperfection, if exists (Software Development Trends and Perspectives, 2015, 8 Benefits of Agile Software Development Segue Technologies, 2015).

Figure 3: 8 Benefits of Using Agile Software Develoment

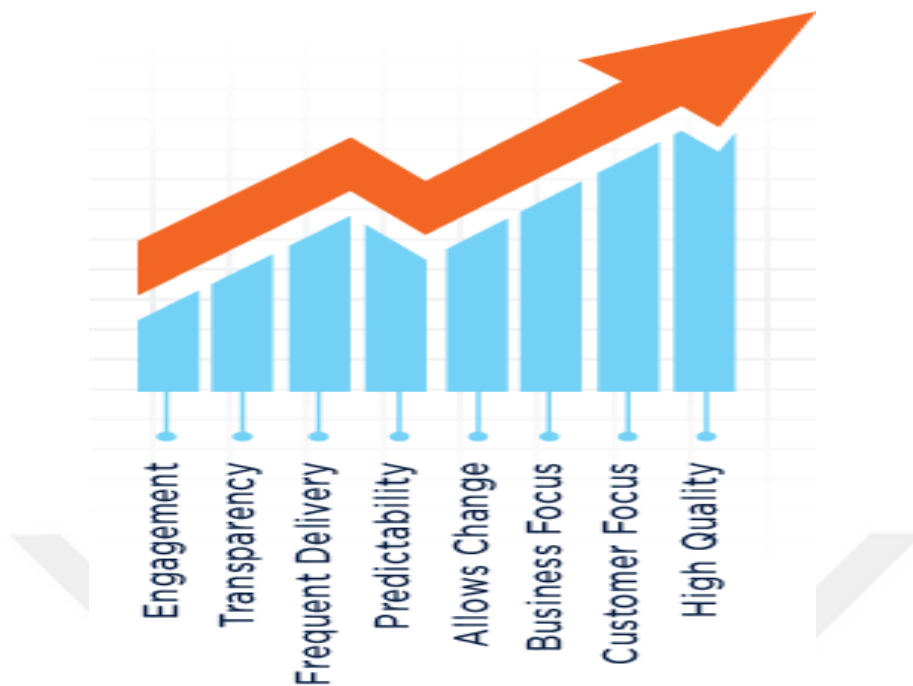Source: 8 Benefits of Agile Software Development | Segue Technologies, 2015

Figure 3 is showing benefits of agile software development. Software teams should pursue agile methods in order to increase flexibility and fast innovation. These explanations complement each other and help to illuminate the phenomenon of quality. Enterprise will have a better quality by breaking down the software projects into the parts. Employee may focus on high quality development by seeing a little part of the software project.

Frequent buildings and testing can improve quality during all phases. Agile is a very fundamental method in software development. It gives benefit to not only the development team but also the clients. Many of the most common projects in business can be dealt with thanks to Agile.

Most of objectives would be achieved by using Agile Software Development (Software Development Trends and Perspectives, 2015; 8 Benefits of Agile Software Development Segue Technologies, 2015; Top 18 Trends in Application Software, 2014).
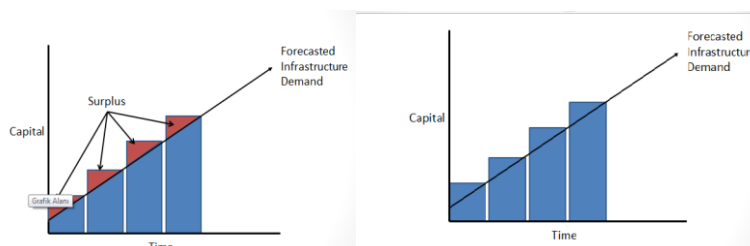
2.1.2. Cloud Computing

'Cloud computing model for enabling ubiquitous, convenient, on-demand access to a shared pool of configurable computing resources. Cloud computing is a general term for the delivery of hosted services over the Internet (What is cloud computing?, 2015).

Several explanations have been offered. I can characterize these explanations as being rooted in Internet. Cloud computing serves many computing resources. It includes e-mail, security, voices over the Internet. It helps save money, time and resources. It helps to share documents. Many users can do it at the same time. It enables users to use more than one device. There are, of course, disadvantages of cloud computing. It needs an Internet connection. It would be an impossible if there is no connection. It also requires high speed connection. It seems that it would be hard to access even user's own documents with low-speed connection (What is cloud computing?, 2015).

Moreover, according to my experience on cloud computing, sometimes it may be low even with high-speed connection.It is because web-based applications. The arguments given above prove that some of problems may arise for users during the adaption of cloud computing. Running application between cloud based systems would not be possible.

Figure 4: Traditional Infrastructure Model in Business

Source: Cloud computing,2016

Figure 4 is showing traditional operating model providing a view of any organization. Businesses make big investments on IT Infrastructure. It is logical to admit that it is extremely expensive to manage software and hardware for any businesses.

Broadly speaking, managing software and hardware more expensive for small to medium sized enterprises because they are just entering to the market. On the other hand, company does not want spend money on employee. Given this evidence for Cloud, an examination of the factors that impact upon many companies start to turn to cloud solutions seems warranted.

Cloud includes three important things: cost effective, scalable IT model and agile. It is delivery of services via using Internet. Cloud storage is another cloud services that helps client to access their space by using the Internet. There are several attractive benefits of using Cloud Computing including; Self-service provisioning, elasticity, pay per use.

Cloud computing helps reduce the complexity of networks. Businesses do not have to buy software licenses by using Cloud Computing (Traditional IT infrastructure vs the cloud, 2016, Introduction of Cloud computing, 2015, What is cloud computing?, 2015).

2.1.3. Software As A Service (SAAS)

Business should specify security, quality of service, and also performance. Software as a Service is a way of delivering data over the Internet-as a service. People can access SAAS application from anywhere by using computer or mobile devices. Software as a service available for use it as an online. Users do not need to download the service. There are many advantages of using SAAS. It decreases scale of demand. It enables not only save money but also focus on budgets. SAAS eliminates the need for business to get the installation (What is Software as a Service (SaaS), 2015, What is cloud computing?, 2015).

Software as a service is like a bank. Moreover, one argument against this cannot be ignored: banks provide a security of their customer. They provide service which is reliable. All of bank clients use the same system to access their personal system or account. They do not feel uncomforted while using same technology. There are some characteristics of the SAAS model (What is Software as a Service (SaaS), 2015, What is cloud computing?, 2015):

(1) Multitenant architecture,

(2) Easy customization,

(3) Better access,

(4) SAAS trends

(5) SAAS harnesses the consumer web

2.1.4. Service-Oriented Architecture (SOA)

Service-Oriented Architecture is in middle of people, process, platform, and practice. Security, quality of service and also performance should be specified by business. Service-Oriented Architecture helps to find a standard way of software. It provides new application into the system.

Different ownership domains can be used by using SOA. It provides to find needs and capabilities in businesses. Organization would focus their development effort better with the help of service-oriented architecture (SOA, 2015, Stevens, 2015).

Figure 5: Preservation Assets
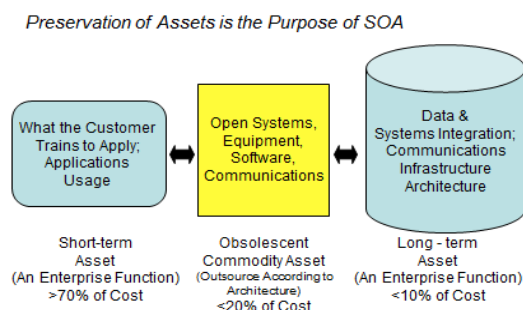
Source: Stevens, 2015

Figure 5 is showing the concept of the service. This makes it possible to introduce other ideas. Preservation of Assets is the purpose of Service Oriented Architecture.

2.1.5 Modern Scripting Language

A modern scripting language is combination of programming. It is preferred to be collected rather than assessed.

CHAPTER THREE
LEAN SOFTWARE DEVELOPMENT

3.1. LEAN THINKING

Failure to obtain the data in the desired ratio of IT products and services used in the enterprise carried out to implement lean thinking in the businesses. Lean thinking firstly applied in manufacturing sector has gained importance in software technology used in management system. Productivity provided by lean thinking affect all the other departments other than manufacturing. Since the IT departments in enterprises that carry the most broad-minded features, improvements to be made in this area carries an inspiration for other departments. Production processes are the basic idea of lean thinking. On the other hand, lean principles are very common among the other disciplines. Employee in many organizations always thinks about what s/he can do better. There could be observed many attempts to apply lean production practices to software development. Even if the organization has many attempts to apply lean principles, they would be unsuccessful. It is because that assuming, generating good software is a production process. Organization should have an idea about generating software is a development process (Bilgi Teknolojileri, 2015, What is Lean Thinking?, 2015).

The concept of lean thinking in the process of producing goods and services aimed at the destruction of loss having regard to the concept of value from raw materials to delivery of products and services. The concept of Lean thinking aims that the value to be streamed at minimal downtime and it will reach to the ultimate customer in fastest way. Even, many things are known about Lean principles; many organizations are not successful while applying them. It is because that lean thinking needs a change not only in culture but also the organizational habits. All principles are universal, but sometimes, it might be hard to see to apply to particular environments. On the other hand they give specific guidance on what to do. However, important thing is to adapt them to the domain. Lean software provides effective management of the process of applying the concept of software processes.

Lean thinking is not only used production today, but also services, construction, health, IT, and also the many issues that we can find (Yalın Enstitü, 2016, Poppendieck and Poppendieck, 2015). '*The machine that changed the world*' was first published, 'Lean' as a word, was started to hear. Even, the meaning of the 'Lean' identified as 'simplicity' it has been identified as 'wasteful war' since 1990. Lean thinking defines the value from the perspective of customer. There are five basic structure of lean thinking (Principles of Lean, 2016).

    (1)   Identifying value

    (2)   Mapping the value stream

    (3)   Creating flow

    (4)   Establishing the Pull

    (5)   Seeking the Perfection

Figure 6: Five Basic Structure of Lean Thinking

Source: 5 principles of Lean , 2016

Figure 6 is showing the five step thought process for guiding the implementation of lean techniques. All of principles are fundamental for elimination of waste. We can easily remember these principles. All of principles could be guide for every organization becoming to involve in the Lean transformation. If any organization wants to implement a sustainable Lean system, the organization needs to know Lean thinking.

The other important point is to understand customers and what they value. In order to get the organization focused on these needs, value stream or processes should be defined. Wasteful activities that customers would not wish to pay for, will need to eliminate or, at least reduce to satisfy customer's needs.

The framework is prepared well, helps to deliver value to the customer. It would be used as toolkit to make the change. Lean thinking provides effective management philosophy for the development processes. Lean production, aiming increase to efficiency and decrease to waste, examines the organizational processes from a customer perspective. Therefore, Enterprises applying lean production principles, manage their processes through map value stream.

The value streams eliminate wastes in the process. On the other hand, Lean manufacturing is a production system responding customer request at the shortest time and minimum defect production. Lean thinking and Lean production provide many advantages to businesses. One of advantages is financial issue. This issue provides to decrease cost that causes wastes. It also helps to prevent unnecessary stock. Low-level inventory affects the total of the bottom financial statement as a negative. This might cause wrong decision. Due to this issue, some of managers can oppose to lean application and development (Terzi and Atmaca, 2011).

There are five basic necessary principles for the implementation of lean thinking in business as follows (Terzi and Atmaca, 2011: 451).

> (1) The determination value by defining what customer value is, in a product service.
>
> (2) Determining the value stream and eliminating the value-added activities.
>
> (3) Ensuring the continuous flow for value-added activities.
>
> (4) Creation pull mechanism through determining what and when the customer wants.
>
> (5) Working for excellence in order to ensure lean development.

Product and/or service with definite specifications, for which the customer is ready to pay for, that meets the customer's needs in a given period, with a definite price.

There are three types of activities in a value stream: Value Adding: Transformation of raw material to product as the customer wishes. Business Value Adding: Die change, adjustment, grasp/release tool. Non-Value Adding: Waiting, counting, sorting, defect, rework (Borusan Akademi Portaloji, 2015).

If organizations learn to see waste, they will achieve the first step in developing breakthroughs with lean thinking. Agile software development always looks for eliminating waste.

There are numerous tools and methods to apply these principles in business. Some of them are as follows:

(1)   Value Map Stream

(2)   5S

(3)   Just-in-Time

(4)   Visual Management

(5)   Cellular Management

(6)   Kanban

(7)   Kaizen

Value Map Stream provides information about activities causing wastes, where those activities arise, and how they eliminate. Mapping our value stream is a very good way to discover the waste in our software development process.

Figure 7: Lots of Companies

Lots of companies

process ➡ process ➡ process ➡ process ➡
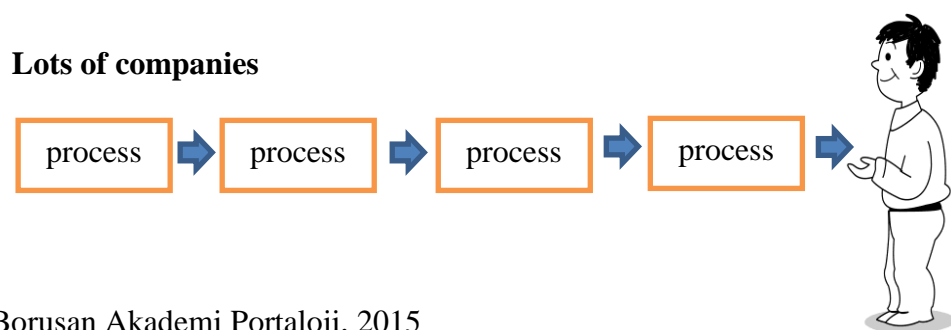
Source: Borusan Akademi Portaloji, 2015

As it is shown as Figure 7: All activities in the value creation process are as follows;

(1) Transformation of concept to design

(2) Transformation of raw material to product

(3) From the furthest supplier to the end user

It leads to see deeper inside regarding to internal process. We can easily see how it works or does not work. *By mapping your value stream, you say to yourself and your organization, "First and foremost, our mission is to provide customer value* (Poppendieck, 2003: 23).

Value stream map can be easily created while walking around in any organization by using paper and pencil. We can find the solution with pretending ourselves as a customer request, and imagining ourselves, passing through the all steps in our process. The value creation process includes some parts:

(1) Transformation of concept to design

(2) Transformation of raw material to product

(3) From the furthest supplier to the end user

(4) Product focused (Borusan Akademi Portaloji, 2015)

We do not need to talk to anyone in organization while doing this, the only thing is to walk around and look at the data. Value stream map give the start point for assessing and improving our software development process. When we have a value stream map of our organization, the following step should be to extend it our customer. If we can understand how our customer creates value, we have a big tool to help them realize that value. However, many things are known about Lean principles; many organizations are not successful while applying them. It is because that lean thinking needs a change not only in culture but also the organizational habits. All principles are universal, but sometimes, it might be hard to see to apply to particular environments. On the other hand they give specific guidance on what to do. However, important thing is to adapt them to the domain. It is better to decide as late as possible as it gives an effective management in domains.

Customers and users need a time to realize their real needs. Agile software development should have been created in order to decide as late as possible. Agile software development environment enables customer to decide their needs as soon as late. So, agile software averts technological invests (Poppendieck and Poppendieck, 2015). Lean focuses on creating value for the customer.

Lean leader Toyota identified three key areas to eliminate, or at least to reduce, everything else (Lean Manufacturing Working More Efficiently, 2016).

(1) Muda

(2) Mura

(3) Muri

3.1.1. Muda

It is one of the key concepts in the Toyota Production System. Waste should be reduced in order to increase profitability. Waste could be anything that does not add value to the customer. If a component sits on a shelf which gathers dust, that is waste. If a development cycle collects requirements in a book which gathers dust, is waste. If a manufacturing plant makes more stuff than needed, that is waste. If developer code more features than needed, that is waste. We can talk about the different waste in different sectors. For example, in manufacturing, moving the products is a kind of a waste. Handing off development from one to another group is a waste in product development.

The best thing is to understand customer needs exactly. Understanding customer needs exactly prevent wastes in any sector (Poppendieck, 2003: 13). As a guide, seven wastes were identified by Shigeo Shingo as part of the Toyota Production System. The Japanese call this Muda. The seven wastes are defined as follows (Lean Manufacturing Working More Efficiently, 2016).

(1) Overproduction

(2) Defects

(3) Unnecessary inventory

(4) Inappropriate processing

(5) Excessive transportation

(6) Waiting

(7) Unnecessary motion

If more products are produced than required, overproduction will occur. Overproduction is a kind of waste. It causes other wastes as well.

Overproduction is caused by large batch sizes, unreliable processes, unstable schedules, unbalanced cells or departments. Many defects can be caused due to deficiency or error in documents in the organization. If any organizations have more than enough extra copies of any things or unnecessary office supplies, storage of equipment or documents not to be used for years, all of these cause to unnecessary inventory.

Making a large number of reviews, using a Carbon Copy while sending an E-mail, or inviting additional people to the meeting are examples of inappropriate processes. Unnecessary movement of people or parts between processes lead to excessive transportation. If the organization wait for people, answer, or a device, waiting process will be almost inevitable. In order to complete the processes, taking an unnecessary action causes to the unnecessary motion (CengizPak.com.tr., 2016).

3.1.2. Muri

Muri is one of three types of waste declared in the Toyota Production System. The reason for the Muri is often due to unevenness. Waste reduction can be used in order to increase profitability. The equipment works more time than allowed or, there are more efforts than required.

3.1.3. Mura

It is a production system or non-uniform working system cause operator to wait or be quick in any organization.

3.2. LEAN

In 1990 the book 'The Machine That Changed the World' gave a new name to what had previously been called Just-in-Time or the Toyota Production System. From then on, Toyota's approach to manufacturing would become known as Lean Production. During the next few years, many companies make efforts to apply Lean Production, but it demonstrates remarkably difficult.

Many people can think that Lean is counterintuitive and hard to change long established habits. Organization might implement only part of the system, maybe they would try Just-in-Time without its partner, stop-the-line. Lean Thinking is an approach that aims to get rid of all the wastes (fats) that bring a burden to the system. "Lean: The part of meat that consists principally of lean muscle (fat-free)

There are some basic principles of lean thinking as follows;

(1) Value

(2) Value Stream

(3) Flow

(4) Pull

(5) Perfection

There are also some benefits presented to the customer;

(1) Lean thinking starts from " value "

(2) The producer creates value

(3) The customer can only define value

Figure 8: The System of Road

LEAN PRODUCTION

LEAN VALUE
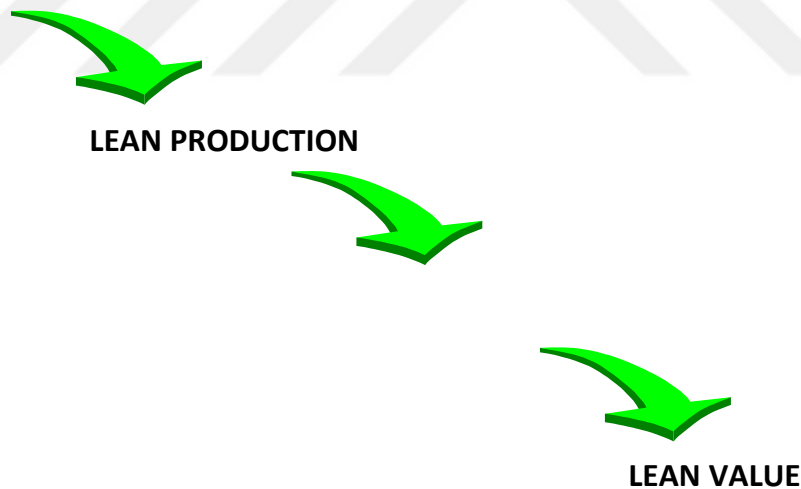
Source: Borusan Akademi Portaloji, 2015

As it is shown as Figure 8, a comprehensive and well-structured system is a must to eliminate all kinds of wastes. Lean operations set the standard for efficiency and effectiveness. In fact, applying lean principles in any organization creates an important competitive advantage that might be surprisingly hard to copy.

Figure 9: Problems

Source: Lean Solutions to Software Product Management Problems, 2012

Figure 9 is showing lean solutions to software product management problems. Generally, problems can be solved by applying the lean principles. It plays an important role in the development of products.

3.3. LEAN SOFTWARE

Lean software development is one of the most important issues of lean information systems. It is difficult to define lean software development as there is no particular met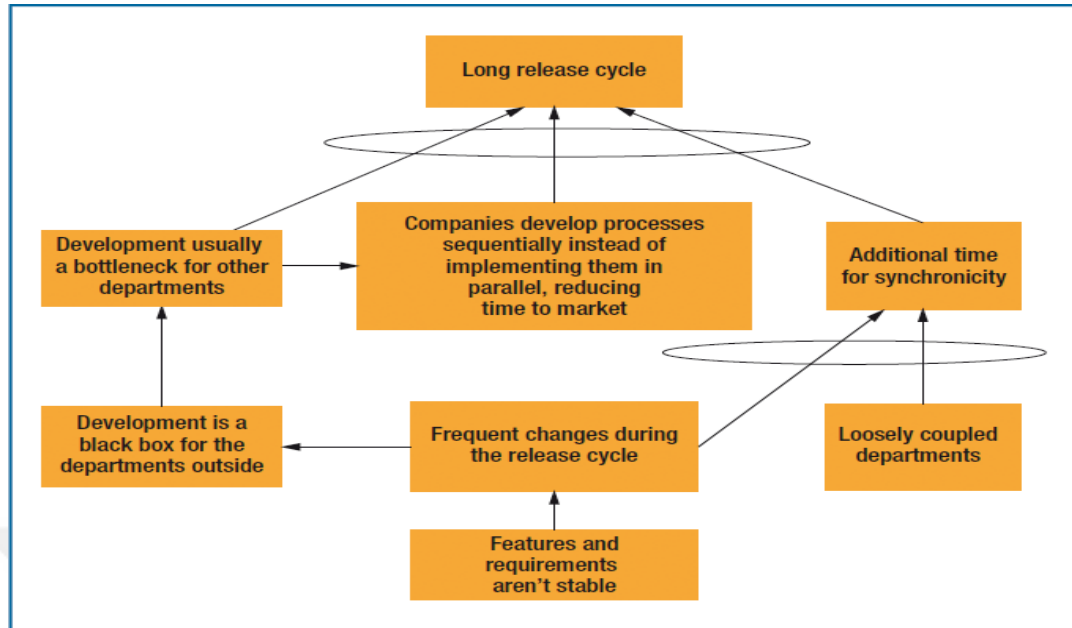hod or process for development of lean software. Those looking for a simple way to monitor the software development process will be disappointed.

In this case, the thing to be done is to understand the principles of lean thinking and adapting to the base lean value creation in our own software development process (Lean Software Development, 2016). Product and/or service with definite specifications, for which the customer is ready to pay for, that meets the customer's needs in a given period of time, with a definite price. There are many activities in the software development processes. However, there are some activities in common as follows: Software specification, software design and implementation, software validation and software evolution.

These processes might take many times. Due to managerial deficiencies, software projects cannot be completed entire satisfaction and success. There are many problems seen in the software development process such as; inability to serve software versions on time, unable to respond request quickly, and noticing the problems too late. Agile methods have been developed in order to find a solution such problems (Ulusal Veri Tabanları, Veri Tabanı Seçimi, 2016).

Agile methods aim to produce products to market quickly, to move quickly facing of changing request. Agile methods are software development tools in order to be used to make more efficient software processes and at the same time to shorten this processes and to provide inexpensive solutions. There are agile methodologies known as Extreme Programming (XP), Scrum, Agile Unified Process, Future Driven Development (FDD), LEAN Development, Dynamic System Development Methodology (DSDM) and Microsoft Solution Framework (MSF).

Figure 10: The Lean Family Tree
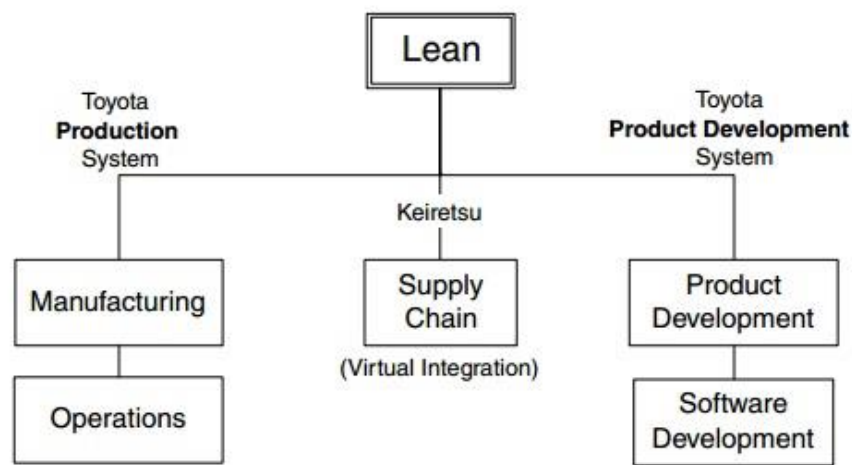
Source: Poppendieck and Poppendieck, 2016

Figure 10 is showing the Lean Family Tree. Customer requirement should be identified in detail, technology in accordance with general architecture should handle. Software projects that are developed by using agile methods increase motivation in company. Customer requirements must take into consideration in order to be successful in projects that will be developed by using agile methodology.

In this context; constraints, team and agile practices should be combined in an optimal way. Hierarchy increased and organization turn into complicated structure in growing companies can be simplified by applying lean thinking. Increasing customer satisfaction, decreasing labor turnover rate and increasing the profit are among the most striking results of lean information systems (Örnek Bir Yalın Bilişim Dönüşümü, 2016).

Products and services developed in accordance with customer expectations in Lean Software development affects customers. Among the innovations made in this respect covers completing customer transactions in a faster way and using less operation. That result assists to improve customer momentum. In general, Software Company offers customers standard screen designs with software packages such as ERP, CRM in order to make updates quickly (Bilgi Teknolojileri, 2015). If we develop the software, we firstly start to develop product.

Actually, much of the software that we use is probably purchased as a product. Product that is embedded in hardware may be the software, developed as a stand-alone product. There is some custom software developed as part of a business process. Customer do not purchase the software we develop, they buy only the processes or the hardware device.

3.4. LEAN PRINCIPLES

Lean thinking contains seven principles and tools for implementing each principle into agile practices.
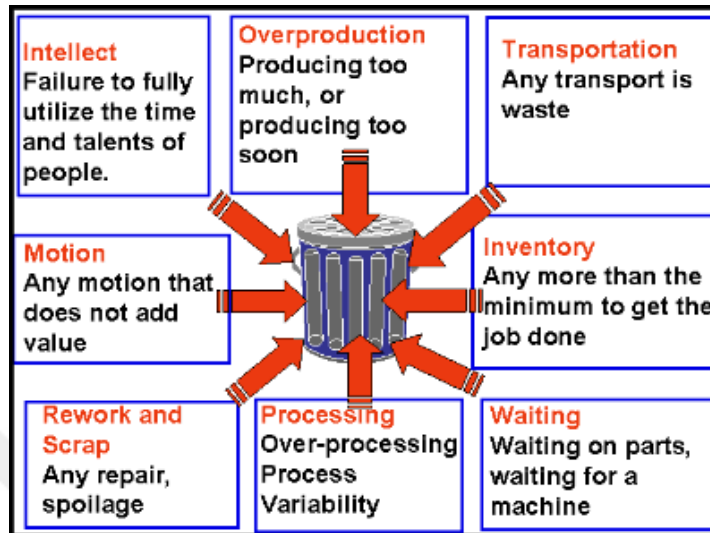
3.4.1. Eliminate Waste

As mentioned above, before understanding value, we should get the meaning of waste. Waste is not about turning the light off or turning the tabs on. Waste is anything does not add value to goods and services.

Waste could be different type in different area including from producing more, unnecessary waiting and keep moving from place to place, to wrong operations.

The best idea is to find out customer expectations, then making them exactly what they want. Briefly, everything that does not meet customer satisfaction is waste.

Figure 11: Waste

Source: Lean Mastery Course, Eliminate Waste, 2015

Figure 11 is showing the kinds of wastes coming in many different forms and categorized in a variety of ways.

3.4.2. Amplify Learning

Before the process is discovered, it should be developed. Development is a kind of exercise. On the other hand, production is an exercise in decreasing variation. Development is a kind of creating a recipe, while production is like making the dish. Experienced chefs having developed an instinct for what works or the capability to implement available material to suit occasion, design recipes.

Even great chefs produce several variations of a new dish; they try it many times to produce a recipe which will taste great. It is known that experienced chefs do not get a recipe perfect on their first attempt; it is expected them to produce it several variations on a theme as part of the learning process. As a result, best idea to improve software development is to amplify learning.

3.4.3. Decide As Late As Possible

There are always some uncertainties associated with software development. Achieving better results always come with an option-based approach. If we have an option to delay decision as much as possible, we will have a chance to correct mistakes.

The more complex a system is, the more capacity for change should be built into it, thus enabling the delay of important and crucial commitments (Lean Agile Approach, 2015)

Deciding as late as possible enables to adapt changes and correct mistakes that may be costly after the release of the system. The basic idea is to wait until as late as possible before making a decision. The idea enables the process to gather information and to make the most informed decision. The Poppendiecks state that delaying decisions is valuable because better decisions are made based on fact and not speculation, and a key strategy for delaying decisions is to build the capacity for change into the system (Craig on software development, 2015, Poppendieck, 2003).

Deciding as late as possible can be thought as cautious while making infrastructure decisions. Developers should think carefully while making a decision. When the organization faces with uncertainty, they try to find an option to provide a way to prevent locking in decision.

3.4.4. Deliver As Fast As Possible

It has been valued to develop software rapidly, recently. Companies was focusing on 'do-not-make-any-mistakes' approach. However, 'speed costs more' to join 'quality costs more' idea has gained importance. There are many advantages of using rapid development. If there is no speed, decisions cannot be delayed. Reliable feedbacks cannot be reached.

3.4.5. Empower The Team

Occasionally, conducting employee surveys is a common idea to define the workplace concerns, workflow processes, and also success stories. Some of stories can get lost time, especially it was occurred many times ago.

Proper action should be taken in order to prevent disorder in the organization. All the processes should be constructive and respectful (Poppendieck, 2003). There is always only one person, who actually does the work, understands the details better. Understanding details of technical decisions is very important to achieve excellence.

'The people on the front line combine the knowledge of the minute details with the power of many minds. When equipped with necessary expertise and guided by a leader, they will make better technical decisions and better process decisions than anyone can make for them. Because decisions are made late and execution is fast, it is not possible for a central authority to orchestrate activities of workers (Poppendieck and Poppendieck, 2015).

Lean systems use pull techniques in order to schedule work. With using pull techniques, employees can let each other know what needs to be done. Pull techniques are kind of an agreement to deliver increasingly refined version of working software at regular intervals. There are some benefits of pull system as follows:

(1) Resources are only allocated to products that are demanded

(2) No inventories are formed on the value chain

(3) Financial turnover (cash flow) speeds up

(4) Regulates the value stream according to the customer

(5) Problems like ; Obsolete finished goods inventory at hand; rework or scrapping of products due to design changes; discount campaigns for undemanded products, do not arise.

3.4.6. Build Integrity In

It is very critical idea while creating perceived integrity. In the process of development any software needs an extra level of integrity maintaining its usefulness over time. It is always expected involve nicely as it adapts to the future. According to research, some particulars cannot be adequate, even if they are integrity with fully wise leadership, concerned expertise, effective communication, and healthy discipline; processes, and procedures (Poppendieck and Poppendieck, 2015).

3.4.7. See The Whole

Seeing and optimizing the whole have lots of advantages in lean system. It helps to identify all pieces. It is because there is always common way to optimize and see the whole. There is a typical response to solve any problems. It is all about break the problems down into their constituent parts. It should also be optimized each individual pieces in order to get best result. There are many ways to see the whole. First of all, we must focus from customer request to deployed software. A complete product should be developed instead of developing only software. And also this complete product has to be done by complete team. Process capability should be measured by cycle time.

Team performance should be measured with delivered business value. Also, customer satisfaction should be measured with a net promoter score. On the other hand, software systems nowadays are not only the sum of all parts, but also the product of their interactions. Integrity needs an entire expertise in different areas. One of the most desperate problems is to know about databases. It is getting harder to find an expert in any area.

When the problems are solved by experts, the system will have a tendency to increase the performance of the product. So, at the end it will be better for all for their own specialty rather than giving ourselves over to entire system performance (Johnny, 2015).

Figure 12: Current State
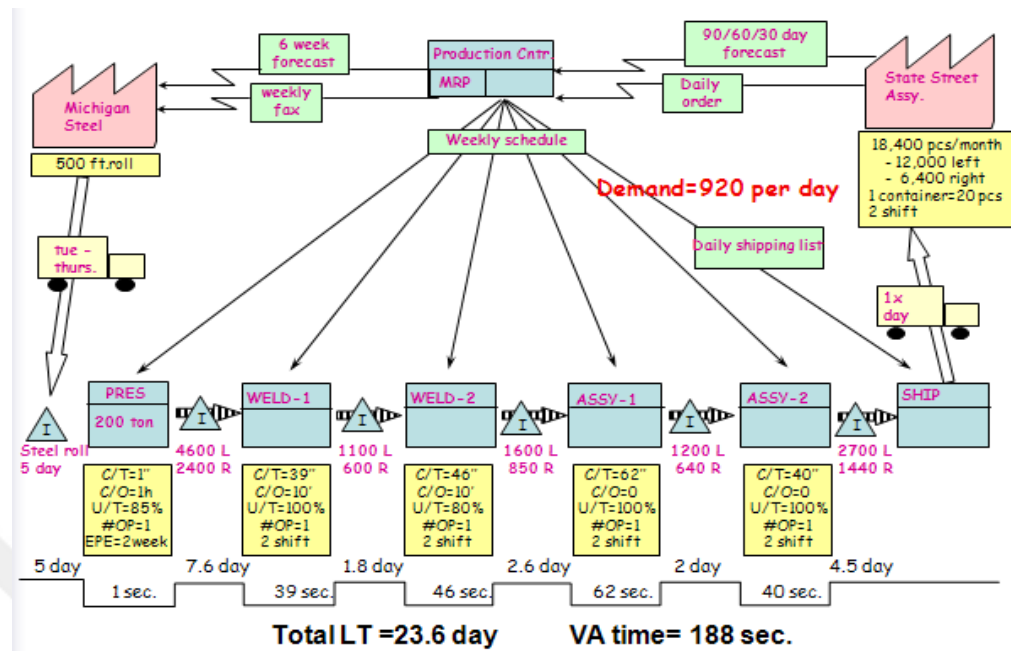
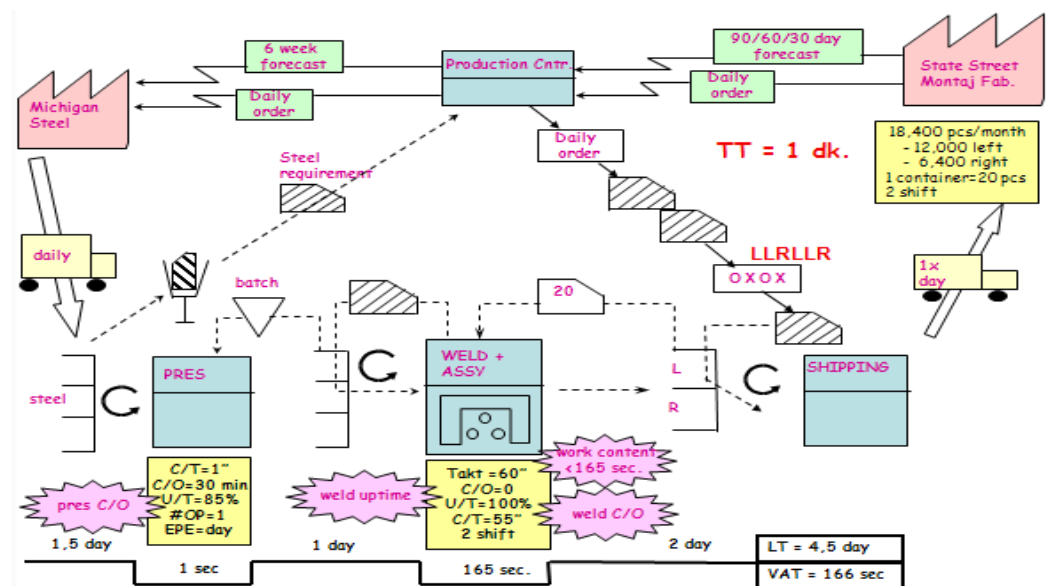

Source: Borusan Akademi Portaloji, 2015

Figure 13: Future State

Source: Borusan Akademi Portaloji, 2012

3.5. LEAN APPROACHES IN AGILE SOFTWARE DEVELOPMENT

Agile methodology is used in software development. It is a useful methodology for the organization to find a solution for undecided situations. According to Agile literature; Agile Alliance includes: eXtreme Programming, Scrum, Dynamic Systems Development Method, Crystal Methods, Feature-Driven Development, Lean Development, and Adaptive Software Development. Even their specific techniques are different; they have a lot in common. These methods provide short iterative life cycles, quick and frequent feedback from customer and constant learning. It is generally agreed today that lean adoption is spreading. The authors of more recent studies have proposed that lean approaches are claimed to be '*the next wave of software processes'*. Lean approaches may be defined in many ways. Some people argue that the term denotes as just another agile methods. According to Hiranabe, more and more people define lean approaches as '*from Agile to Lean'* (Wang et al., 2012).

Broadly speaking, I agree with increasing profits by delaying decisions because organization may have more time than usual. I believe that there are several reasons. Firstly; sometimes; forecast can be a bit off. Before producing, organizations have more material for the company. For some company; their business decisions are static. They do not want to change their minds. Although they are convinced to change their minds, they usually do not want to give their customers the option to change their ideas. Secondly, uncertain subject would not take attention of people; therefore, they would not in favor that kind of subject. Postponing the decision would increase company`s profit. As, there would be more time make a better decision. JIT systems can minimize changeless actions.It is because even there are huge amount of complexity; we may find the right action by delaying decisions. Finally, we should clarify that the system will be no longer too complex.

3.6. MEASURING THE FLOW IN LEAN SOFTWARE DEVELOPMENT

In agile and lean software development, one of the most important goals is to be able to answer customer needs. Organization should have a stable and smooth flow in order to quickly deliver value to the customer. My purpose is to visualize the flow of lean software development by applying cumulative flow diagrams.

The authors of more recent studies have proposed that in order to answer customer needs and expectations, lead time should be reduced. It is important to emphasize that the progress of software product development can be showed by using tracking system. I entirely agree that agile software development must be focused on customer needs. It is now clear that some practices should be done. Let us turn our attention to practices such as on-site customer and frequent releases to customers. Agile practices can be performed by adopting practices from lean manufacturing. All of this points to the fact that lean manufacturing focuses on minimizing waste in the manufacturing process and examining the flow of material through the manufacturing process.

3.7. LEAN PERFORMANCE MEASURES IN MANUFACTURING

Day-by-the-Hour: $\dfrac{\#quantity}{\#hours}$

Capacity Utilization: $\dfrac{WIP}{C}$

- If CU >1 workload is too high
- If CU<1 workload is too low
- The value of 1 is ideal

On-time delivery: $\dfrac{\#late\ deliveries}{\#deliveries\ ordered}$

Source: (Petersen and Wohlin, 2016: 978)

Manufacturing should deliver at the rate the customers demand products. This rate is referred to as takt-time. The quantity is the number of items produced in a day, and the hours the number of hours worked to produce the units. The rate should be equal to the takt-rate of demand. (Petersen and Wohlin, 2016: 978)

CHAPTER FOUR
LITERATURE REVIEW ON LEAN SOFTWARE DEVELOPMENT

After doing the literature review on lean software development, it was understood that there are a great number of case studies regarding to lean software. In this section, the case studies shall be examined that are done in this area. After that, the attention should be on the idea to have been improved on this field. The steps in the progress are certain. Therefore, the case studies should be given more importance to understand the idea comprehensively.

In their article 'Lean software management: BBC worldwide case study' Middleton and Joyce (2012) describes lean ideas depending on the Toyota production system and claims that the system can be applied to software project management. The case study was taken place in London. Data was collected from development team, Kanban boards, the daily stand-up meetings, and statistical analysis. Middleton and Joyce believe that using of lean method has an improving effect on software development. Statistically speaking, lead time to deliver software improved by 37%, consistency of delivery rose by 47%, defects explained by clients fell 24% (Middleton and Joyce, 2011, Lean Software Management BBC Worldwide Case Study, 2015).

According to Nord and Ozkaya, works that is done related to architecture help them to see improvement on architecture development. The work was taken place the Department of Defense. As a result of implementing different plans clarify the importance of significant requirements. They concludes that Kanban should be used not only feature, story or task-level allocation of WIP limits, but also to help a phased-based ideas (Nord and Ozkaya, 2012, Digital Library, 2016).

In the article 'The value of Lean' focuses on lean development. Idea that lean is a kind of trend and would be a fad is in common idea between the authors. However, they disagree whether the lean could be fad. To sum up, whether lean is fad or not, is losing its importance. In the article, they concluded the idea of practices that have to be implemented in the businesses.

According to their experiences at Nokia, works should be limited in progress. Organization should look not only the one part but also the whole part of a value (Erdogmus and Villkki, 2016).

In the article 'Lean software development measures-A systematic mapping', aims to show lean software structure to ISO/IEC 15939. In the study, systematic mapping and thematic analysis were used. Many of contribution were observed. Increasing attention and focusing in relation to lean principles are two of them. The author state that the principle of *defer commitment and only one measure for respect people and create knowledge each.* By and large, measures in industrial use will be needed for further research (Feyh, 2016).

In the study 'What's the evidence for Lean' was revealed the main concept of lean production of its common rendition. According to survey made in IMVP (International Motor Vehicle Program) in 1980s, there are many different of view than the view generally accepted. The main idea of the study is to able to shown that evidence is not an effective results. Organization should always go back to show backside of causes (Dyba, 2015).

In his article 'Waste in lean software development: A root cause analysis' emphasize the importance of removing of wastes. The study aims to make an extensive research to find out wastes cause in the process. They also find out relation between wastes. With the aim of the study, different kind of wastes such as; namely, technical and non-technical, were identified (Medidi, 2015).

In the article 'A business case for feature-oriented requirements engineering' is stated that businesses' efficiency and cost effectiveness would be easily implemented with the help of growing software content. They proposed a feature model like a tree including structure, dependencies, and commonalities. Benefits of feature model were described. Its benefits will include many of advantages.

Product necessity would be determined with the help of customer's domain. It gives capability of management on variability and commonality. It also makes it possible for developers. Four major steps in businesses can be solved with the help of FORE (feature-oriented requirements engineering). The author in this article stated that there would be four key benefits: effective testing, easier bug fixing, transparency and easy overview of product (Rudorfer et al., 2015).

In her paper 'Lean service operation: Reflection and new directions for capacity expansion in outpatient clinics,' Linda R. LaGanga states that electronic health record (EHR) is an important to define the capability of the service operations and test speculation. In this study, it was used original data from the mental health center's service. According to findings, it would be great to give an appointment during 4 p.m. hour. It helps to increase service yield. It was found that service yield would increase as 1.4%. Many of problems were solved by applying lean service operation. Timely access, responsiveness to patient needs is most important thing that needs to be improved. The lean process improvement project and rapid improvement capacity expansion (RICE) were used to achieve better results. After applying new scheduling approaches, 27% increase in service capacity and 12% decrease in the no-show rate were observed.

That verbal feedback from customer is very positive leads us to the conclusion that continuous improvement was be implemented (LaGanga, 2015).

In the article 'Defining and developing measures of lean production' aims to clarify the semantic issue based on lean production. The authors wanted to solve semantic confusion regarding with lean production. Comprehensive and multistep approaches were used. Shah believes that lean production is not a singular concept. It could not be used to waste elimination. Lean production is a multifaceted. They proposed a cognitive definition of lean production. Their definition depends on not only people but also process components. To sum up, their findings would help to increase the potential for concept-travelling and to decrease the problem of production system (Shah and Ward, 2015).

In their paper 'Leagile software development: An experience report analysis of the application of lean approaches in agile software development' focused on agile software development regarding to lean software development. It is commonly understood to mean 'from agile to lean'. They came to understand that lean could be applied in agile processes in different area for different reasons.

An important result found in this study was that applying agile methods into an organization was *'interrupt-driven, not plan driven'* (Wang et al., 2015).

In the article 'A survey study of critical success factors in agile software projects' focused on problem emerged within the process. There had been observed many projects resulted in delayed, failed, abandoned and rejected. They decided to use critical success factors (CSF's) believed to help software project development. Survey was conducted on the Internet. It aims to get feedback from 109 agile software projects from 25 countries around the world. The survey tried to find answer for following questions. *A) Are these 12 factors truly the critical success factors of agile software development projects? B) If so, what is relative importance of each factor when compared to other factors?* It was implemented on five different categories: Organizational, people, process, technical, project. The result gave a very good improvement on quality, scope, time, and cost. It is important to emphasize that first question answer is obviously certain. It would not be possible. There are only six critical success factors of agile software development. To sum up, this study has a failure regarding to find evidence for success in agile projects. The study does not include some critical factors for success like a strong sponsor commitment (Chow and Cao, 2015).

In the study 'Obstacles to decision making in agile software development teams' stated that decision making process in agile development is so critical. The study focused on four stages of iteration cycle: Iteration planning, iteration execution, iteration review, and iteration retrospective. It was conducted with 43 agile developers and managers. It was aimed to determine decision making process at different point. The study gave team to make better decision making process than individuals. It is because team has many knowledge and information. However, it does not mean that team will not be faced with trouble. They would face many obstacles including getting information or conflicting priorities for decisions. The study would help agile software development teams. They would improve their iteration delivery (Drury e al., 2015).

Figure 14: Lean Transformation

Figure 14 is showing the Lean Transformation.

Waste Elimination	Put Safety First	Actively Listen
Pull	Take the Customer's View	Visual Processes
Make Value Flow	Go, See, Act	Align the target
Standard work	Stop to Fix	Act Decisively
Level out of the workload	Develop People & Leader	
	Learning Organization, Kaizen	

Source: Borusan Akademi Portaloji, 2015

It is clear that software development should be based on customer needs and some practices should be done dependently. It is in point now to turn our attention to practices such as on-site customer and frequent releases to customers. Agile practices can be done by adopting practices from lean manufacturing. All of this points to the fact that lean manufacturing focuses on minimizing waste in the manufacturing process and examining the flow of material through the manufacturing process (Claes and Wohlin, 2016). There are some general characteristics of mass production; Borusan Akademi Portaloji (Borusan Akademi Portaloji, 2015):

(1) Production with lot sizes as big as possible
(2) Layout according to machine types
(3) Long changeovers
(4) Buffer inventories against possible production problems
(5) Detailed division of labor
(6) Single skilled workers
(7) Quality based on control
(8) Management through central planning

(9)   Production planning based on sales forecasts

(10)   Point efficiency

(11)   Priority of capacity utilization

There are also some problems with mass production (Borusan Akademi Portaloji, 2015):

(1)   Long delivery times

(2)   Weakness in responding to customer demands

(3)   Increase in inventories

(4)   Decrease in quality

(5)   Increase in non value adding activities

(6)   Work becoming more complex everyday

(7)   Increasing hierarchy and bureaucracy

(8)   Additional costs

(9)   Difficulty in adapting to variations

With the help of Poppendieck, who exemplified the number of lean principles and practices can be run in a software engineering context; the software engineering group realized the importance of lean principles and practices. Lean software development partakes in essentials of people management and leadership swiftly. This aims to set sight on quality and technical perfection. There is a difference between agile and lean. As distinct from agile lean focuses on the end-to-end perspective of the whole value flow through. There are number of tools to examine and develop the value flow. These tools include Kanban, Value Stream Mapping, Inventory Management, and Pull System. Value should flow, at the time, for the products, at the speed demanded by the customer. There are some benefits of pull system (Borusan Akademi Portaloji, 2015):

(1) Resources are only allocated to products that are demanded

(2) No inventories are formed on the value chain

(3) Financial turnover (cash flow) speeds up

(4) Regulates the value stream according to the customer

(5) Problems like ; Obsolete finished goods inventory at hand; rework or scrapping of products due to design changes; discount campaigns for undemanded products, do not arise.

It's a good opportunity to repeat the principles five simple principles to avoid focusing solely on the techniques;

(1) Specify value from the standpoint of end customer

(2) Identify the value stream for each product family

(3) Make the product flow

(4) So the customer can pull

(5) As you manage toward perfection

Figure 15: Pull System
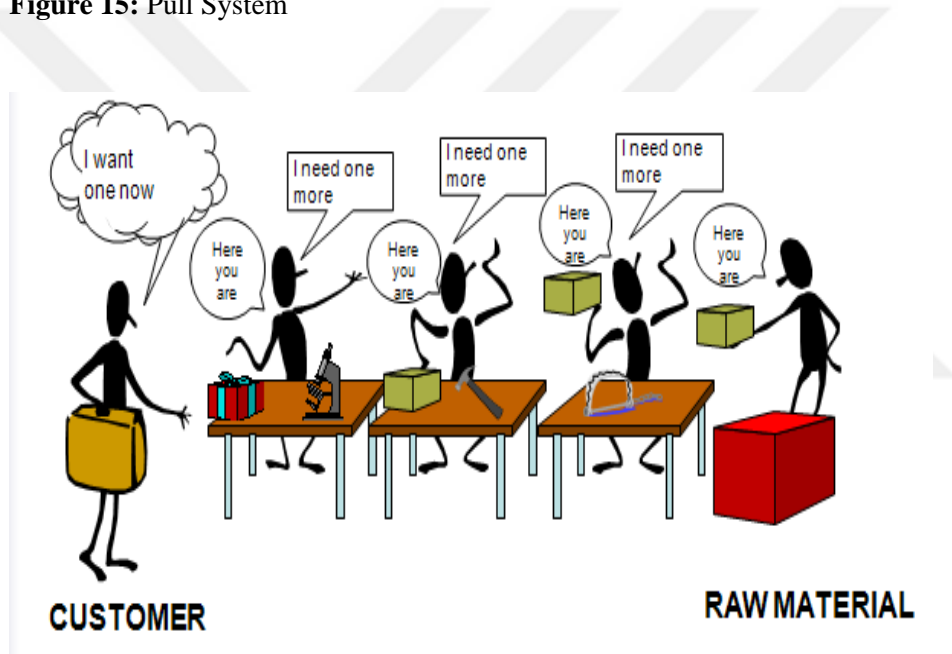
Source: Borusan Akademi Portaloji, 2015

Figure 15 is showing the Pull System that is a lean manufacturing strategy used to reduce waste in production process.As it was mentioned before Value Stream Mapping aims to visualize the development life cycle. Development life cycle shows processing times and waiting times. Inventory management aims to reduce work that does not add value. Two brief examples might clarify this concept.

The results of the case studies of Middleton; which is about lean implementation in software engineering, demonstrated that using the lean method gives the different result between the organizations having different perspective. Teams in the organization cannot adapt lean methods because of a number of varied reasons. From my point of view, organizational hierarchy is the primary amongst this. The errors made by them could be easily visible. So, they do not want their faults to reveal. On the other hand, organization, using the lean method for a long time, can apply unnecessary steps. It causes the decrease in productivity (Petersen and Wohlin, 2016).

Figure 16: Perfection
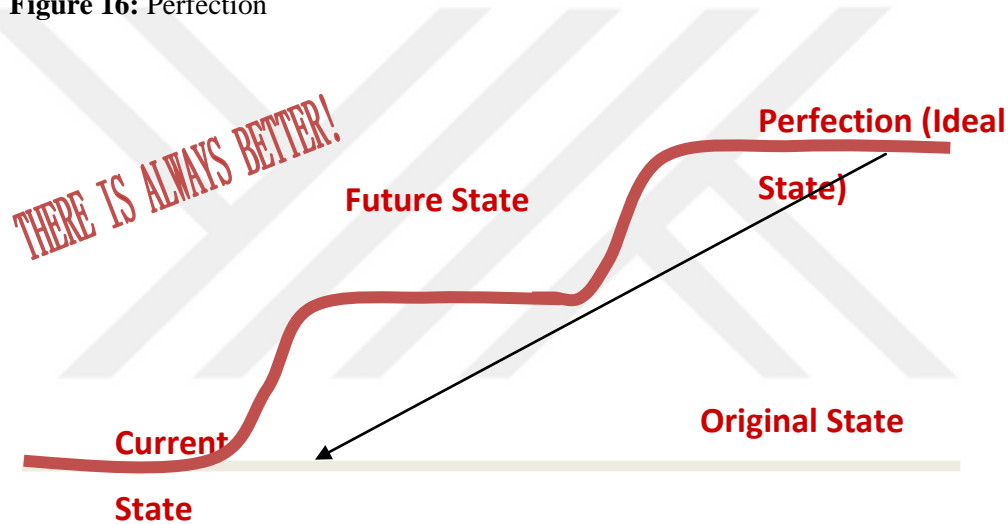
Source: Borusan Akademi Portaloji, 2015

Figure 16 is showing the way of perfection. It is generally agreed today that unnecessary coding, delaying in software development, requirements that are not defined exactly, and slow communication between departments cause waste. When then review the factors, we can easily make the definition of waste. Companies can eliminate the waste. It is important to be clear about the definition of waste.

Following examples are important to emphasize that (I) if developers explore more codes than required, (II) if the coding and documentation are in the same direction, (III) if there is a code that is unused, (IV) processes and characteristics that are not used by customer, (V) waiting for other team or other processes, (VI) wrong product or low quality, (VII) general expenses that do not produce value, are kind of wastes.

It meant that in order to eliminate waste, companies should see the waste and define it. Many organizations can use value stream mapping in order to see and define waste. Value stream mapping helps to define waste and helps to eliminate waste. All of this points to the fact that exploring different coding and software instruction perspective can be tried in order to more documentation processes and detail planning.

Understanding customer demand can help reveal better processes. Sharing user interface and getting feedback immediately are effective way. A number of restrictions of the study and areas for future research should be mentioned that the gap between customer and developer has to be clarified in order to eliminate future problems arising between them.

Figure 17: Winners in Lean System
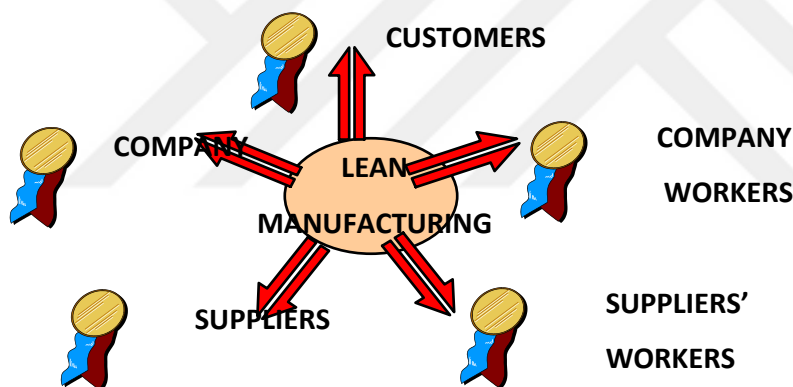
Source: Borusan Akademi Portaloji, 2015

Figure 17 is showing the winners in Lean System. So, customer and developer should be kept in touch in every phase. As competition increases, we have to become lean. We should produce only the products demanded by the customer, at the time the customer demands. We also should consume less resource. We have to focus on the activities that create value for the customer (Borusan Akademi Portaloji, 2015, Yalın Yazılım Geliştirme, 2016).

CHAPTER FIVE

AN APPLICATON IN A COMPANY REGARDING LEAN SOFTWARE

5.1. DATA COLLECTION

Data collection is commonly understood to mean being an important aspect of research study. It is important to emphasize that data collection has a big influence on the results of the study. After having explored the purpose of data collection, many methods were used in order to having many information. This was a very beneficial section is believed to provide a understanding views, experiences of the firm. On the other hand, literature review on lean software development was completed, it was understood that there are a great number of case studies regarding to lean software. In the section, the case studies were be examined that are done in the area.

5.2. TOOLS AND TECHNIQUES

Making a research interview would seem to suggest that it has a distinct advantage of gathering information. It enables my research to establish the company's background and their point of view regarding to lean systems. After preparing some good questions, they were answered by personnel in KerzzPoss. The study serves as a window to an understanding of the process of the system in the company. These answers lead us the conclusions that there are some processes needs to be improved. As predicted, it was very beneficial to use Visio in order to create diagrams and flowcharts to show the elements in coming in and going out. It was also much easier to create a professional diagrams.

5.3. ANALYSIS AND FINDINGS

The companies used in this work were selected considering the writer's interest. In the initial stages of the work, a comprehensive investigation was done in order to find a valid and useful company.

After a long period of toil, the work on this theses were decided to be applied on the company named *KerzzPoss* and the works, which lasted quite a long time, started with the company after this decision. This application was crucial as it supplied an advantage and opportunity to have an idea of both the actual company and the working life. The experience gained during the works with this company very well combined with the courses taken at the faculty. It can be said that writing a thesis with a company has a number of advantages. Helping create valuable contacts with the business world and increase professional qualifications are two of the advantages amongst others. Getting involved to solve real problem gives us success that we want to see in ourselves. This way, we become happier. Last but not least, I appreciate the time KerzPoss personnel spent with me for this thesis and their advices.

The purpose of critical case analysis is to describe the company overview. I have selected some questions and wanted them to answer these questions. This study found that there are some events to be improved. Firstly, every department should be responsible for their own work. Financial accounts, manufacturing are two of them among them. It is a well-known fact that some conditions have to be fully prepared in the company. As an example configuring a wireless access point is the most important one among them. Actually the physical setup for wireless access is simple. Any problem causes the access only gives the employee to become in unhappy situation. Customer may request many things. The company should be ready for all demand regarding to customer.

By and large, thanks to information technology, data gathering and analytics make the process more clear. The strategies and IT enables the system prudent. So, the interaction between customer and company is getting reliable. The result of the present study demonstrates that the company has some imperfection regarding to business processes. Before setting up the new version into the system, some technical issues should have been checked and fixed up by the technical department. The department should have been decided the conditions the business have. As predicted, the company is not well-prepared before meeting their customer. It leads to trouble between the employee and the customer. It gives the customer negative effect on their future business meeting.

In order to provide an amazing customer experience, customer's expectations should be clarified. It is my belief that new department may be set because it make sense to divide workload into the part. In the company, customer support contact centers need to develop their attitudes towards their customers. It means that they should look customer's point of view. It can be seen from answers that they have a problem of lack of information regarding to the company support services. Customer should have an idea about after sales services. Sales department may define their after sales services. The majority of their customers are dissatisfied with the service they receive from the company support service.

This majority should suggest that support service they provide must immediately change or they have risk losing them. There is no doubt that the support staff and the developers are often the same people in a small company. The developers know the product better than anyone else. Developers can communicate the customer easy way and a short time. Developers also have an idea about the problem. Direct feedback gives the customer idea regarding to future product. With the reasons above, small company has a more opportunity to develop their product than a big-sized company. It is true that developers can develop their products while serving support service, yet the remains fact that the more time developers spend on support, the less time they can spend doing development (33 tips for giving great technical support at a small software company without being swamped, 2012).

Takt time is an important issue to understand the demand of customer. We may see the rate at which products and services should be produced to meet the customer demand. *'It is derived from the German word, Taktzeit, which is often referred to as the heartbeat or drumbeat of production in Lean Manufacturing.* Takt time synchronizes the pace of production with the pace of sales. Assembly speed based on sales speed (Borusan Akademi Portaloji, 2015, Takt Time, 2016).

$$\text{TAKT TIME} = \frac{\text{Available time per day/shift}}{\text{Customer demand per day/shift}}$$

The classic way of calculation Takt time is very simple: Available minutes for production/Required Units of production). This is not a wrong calculation. However, people tend to get wrapped up around what constitutes 'available time'. It means that we should consider many of activities such as: breaks, meetings, and other administrative non-working time. The purpose of Takt time is not really necessary. Many companies operate it without knowing what exactly it is. Takt time enables businesses being more productive. Takt time can be used in any sector including; customer services, call center, or delivering the product (Takt Time, 2016)

Figure 18: Takt Time

A shift= 4daysx 10 hou					
Net Available Time			**Customer Demand**		
Working shifts / day	2	shifts	Customer demand / day	1300	pieces
Hours / shift	10	hours			
Available time / shift	600	minutes			
Break time / shift	30	minutes			
Lunch time / shift	30	minutes	Net available time / day	64800	seconds / day
Planned downtime / shift	0	minutes	Customer demand / day	1300	pieces / day
Net working time / shift	540	minutes			
Net working time / shift	32400	seconds			
Net available time / day	64800	seconds	**takt time =**	50	seconds / piece

Figure 18 is showing the Takt Time. Takt time is an important issue to understand the demand of customer. We may see the rate at which products and services should be produced to meet the customer demand. *'It is derived from the German word, Taktzeit, which is often referred to as the heartbeat or drumbeat of production in Lean Manufacturing* (Borusan Akademi Portaloji, 2015, Takt Time, 2016).
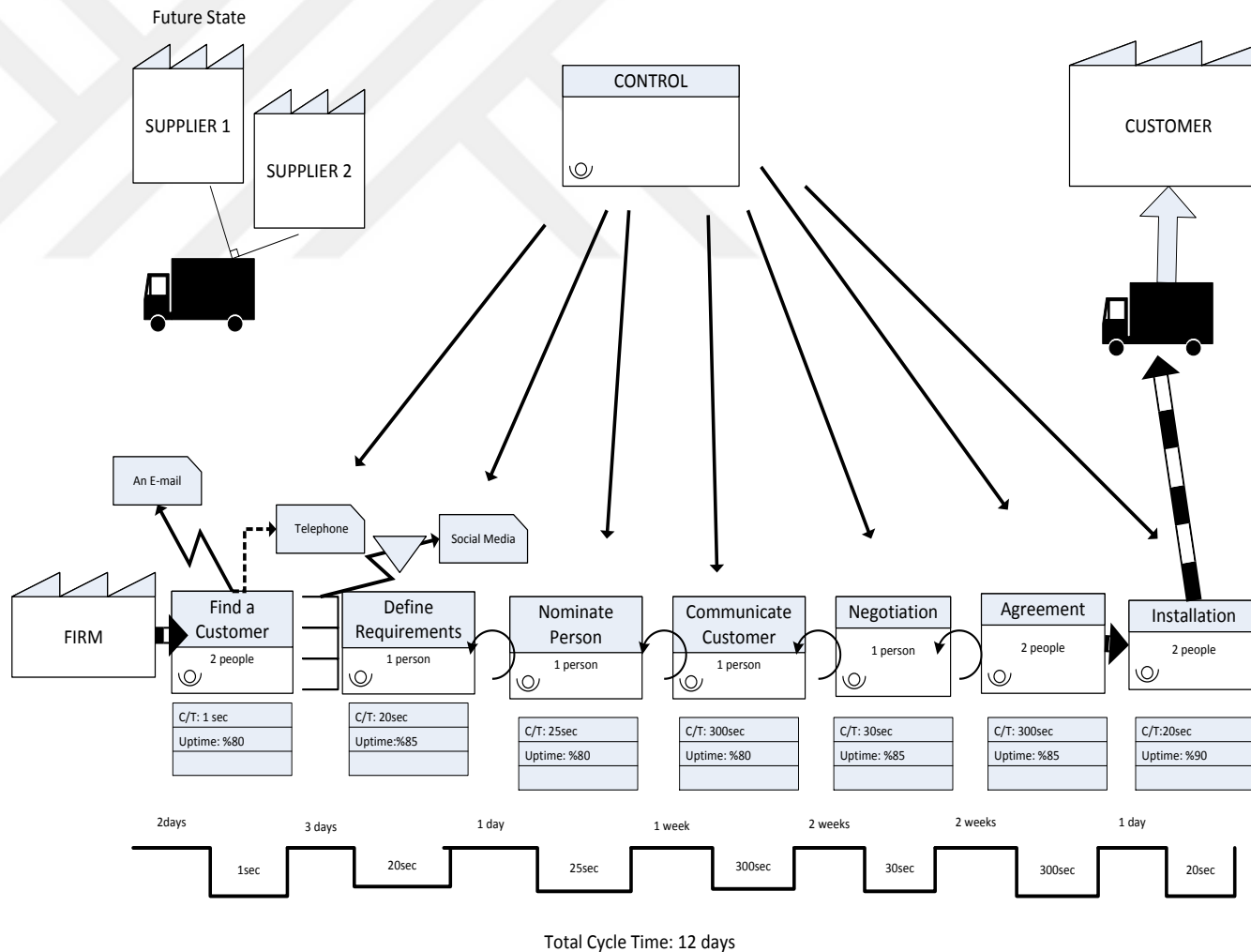
Figure 19: Application of Current State

Total Cycle Time: 81,4 days
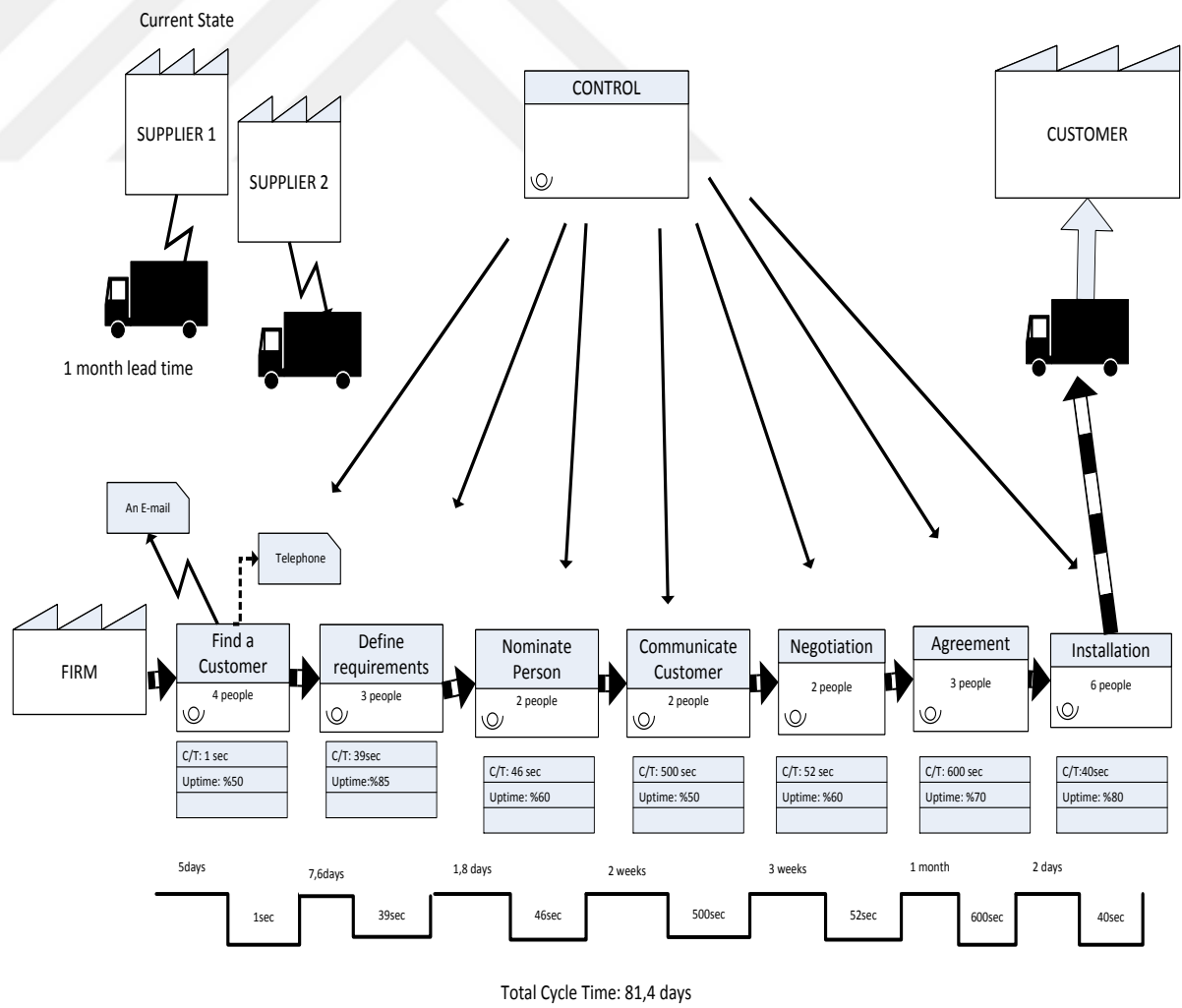
The firm finds a customer either by an e-mail or by a telephone. Some customer also advises them to other customer. If the firm receives an e-mail from the customer, the total duration may take more than 1 hour. The sales representative does not reply the e-mail back purposely. The employee pretends working densely. Sometimes, they receive extra demand from their customer. The more customers want, the more workload employee has. So, the duration of process is getting longer. According to employee in the firm, when the process is longer they start to be angry. Sometimes, they feel unsatisfied. Finally, the duration of final stage can change stock position. To sum up, they do not stop communicating each other because of uncompleted process of their workflow.

The firm wants to be sure if customer's infrastructure is ready or not to the installation. If they are not, the duration takes more than one month. They start to talk about tuition process, after checking all cable that related to installation. They need to decide that where they put access point, printer or any other necessary cable. Tuition can be on the same day according to customer perspective. Additional demand can be added by customer. The firm reminds their customer that extra demands always extend the processes. The firm says that installation can take from one   day   to   three   days   according   to   business   size.

Figure 20: Application of Future State

Future State

SUPPLIER 1

SUPPLIER 2

CONTROL

CUSTOMER

An E-mail

Telephone

Social Media

FIRM

Find a Customer	Define Requirements	Nominate Person	Communicate Customer	Negotiation	Agreement	Installation
2 people	1 person	1 person	1 person	1 person	2 people	2 people

C/T: 1 sec	C/T: 20sec	C/T: 25sec	C/T: 300sec	C/T: 30sec	C/T: 300sec	C/T:20sec
Uptime: %80	Uptime:%85	Uptime %80	Uptime %80	Uptime %85	Uptime: %85	Uptime: %90

2days   3 days   1 day   1 week   2 weeks   2 weeks   1 day

1sec   20sec   25sec   300sec   30sec   300sec   20sec

Total Cycle Time: 12 days

An activity or a process, or even a staff that do not add value to the service for the customer should be eliminated. As seen from above, some changes are applied in order to reduce wastes. The firms find a customer by using two ways. Social media can be another alternative for it.

On the other hand, they do not need more than two employees while finding a customer. It needs to be minimized. By doing this, uptime score would be better. In the firm, there are 3 employees defining requirements. In that phase, canban should be applied. The firm needs only one person in order to find customer requirements.

CONCLUSION

Following debates in software development, scholars have argued that the tradeoff between predictive processes and adaptive processes. It is important to emphasize that software development has to be identified in detail before applying into the system. What I meant is that if we do not get the necessary things; it would be inevitable to see that it will cost to make changes later. It always works in a predictable world. On the other hand, if company face with uncertainty about what customer really need, or whether the technology will change, then adaptive approach will be better. A persistent theme in resolving uncertainty is to limit the cost and time. The authors of more recent studies have proposed that adaptive paradigm of postponing decisions till uncertainty is decreased usually produces better results than a predictive approach.

Organization should have a stable and smooth flow in order to quickly deliver value to the customer. My purpose is to visualize the flow of lean software development by applying cumulative flow diagrams. The authors of more recent studies have proposed that in order to answer customer needs and expectations, lead time should be reduced. It is important to emphasize that the progress of software product development can be showed by using tracking system. After doing the literature review on lean software development, it was understood that there are a great number of case studies regarding to lean software. The case studies were examined that are done in the area. After that, the attention was on the idea to have been improved on this field.

The steps in the progress are certain. Therefore, the case studies should be given more importance to understand the idea comprehensively. A number of restrictions of our study and areas for future research should be mentioned that the purpose of critical case analysis was to describe the company overview. After selected some questions and wanted them to answer these questions, the study found that there were some events to be improved. Firstly, every department should be responsible for their own work. Financial accounts, manufacturing are two of them among them. It is a well-known fact that some conditions have to be fully prepared in the company.

As an example configuring a wireless access point is the most important one among them. Actually the physical setup for wireless access is simple. Any problem causes the access only gives the employee to become in unhappy situation. Customer may request many things. The company should be ready for all demand regarding to customer.

By and large, thanks to information technology, data gathering and analytics make the process more clear. The strategies and IT enables the system prudent. So, the interaction between customer and company is getting reliable. In order to provide an amazing customer experience, customer's expectations should be clarified. It is my belief that new department may be set because it make sense to divide workload into the part. In the company, customer support contact centers need to develop their attitudes towards their customers. It means that they should look customer's point of view. It can be seen from answers that they have a problem of lack of information regarding to the company support services. Customer should have an idea about after sales services. Sales department may define their after sales services. The majority of their customers are dissatisfied with the service they receive from the company support service. This majority should suggest that support service they provide must immediately change or they have risk losing them. There is no doubt that the support staff and the developers are often the same people in a small company. The developers know the product better than anyone else. Developers can communicate the customer easy way and a short time.

Developers also have an idea about the problem. Direct feedback gives the customer idea regarding to future product. With the reasons above, small company has a more opportunity to develop their product than a big-sized company. The study aimed to reveal the architecture of a process to ensure effective management of the software development process and integrate necessary tools into that architecture in order to improve processes.Lean techniques such as Kanban, 5S, SMED etc. were added depending on the nature of the improvement points. Simulation and data mining techniques were utilized for efficient analysis of potential improvements which were done.

By combining improvement phase based on lean thinking principles and the process architecture model, aim to reveal an integrated and reference model which had a guide qualification that included guidance to software developers about how to effect improvement on necessary points   and   how to effectively manage their processes. Pilot application was done in order to present potential advantage and how to model was performed. According to statistics 75% of customers would like the method of call back than wait in a queue 48% of customer wants to watch a video in order to solve their problems. 36% of customer prefers to use real-time video chat to communicate support services. 24% of customer would like to interact with a speech recognition system. When we analyze the results from statistics, we can see that majority of customer is not happy with the service they receive from support contact service. In sum up, companies should be aware of understanding customer expectations.

The results of the present study demonstrate that customer want to resolved and answered their problems quickly. Their priorities are their problems. They want to talk with a skilled employee and to have their problems solved quickly. When one looks at the statistics, one can see that customers prefer to use different communication channel. The phone is most used. It is preferred method to communicate with support services. They do not want to explain their problems by writing an E-mail. To me, customers do not want to wait when they are faced with a problem. They want to reach the result that makes them happy.

Admittedly, waiting process gives the people unnecessary thought, but writing the problems gives more details than explaining the problems on the phone. When phone support is not available, customers prefer to use other communication method. E-mail is the most preferred one, if phone support is not available. Actually, there are many options that can be selected by the customer. When we analyze the results from statistics, we can see that majority of customer is not happy with the service they receive from support contact service. In sum up, companies should be aware of understanding customer expectations.

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APPENDIX

APPENDIX 1: Interview Questions and Answers

Here are some good questions to be answered by personnel in KerzzPoss. The study serves as a window to an understanding of the process of the system in the company. So let's have a look these questions. These answers lead us the conclusions that there are some processes needs to be improved.

1. Give us an example of a case when you were satisfied or when you were not, in the interaction with a customer?

   X: Version transition was made in order to upgrade the system performance. Continuous transition caused freeze on the system.

   Y: System update was done in order to make the system better. After updating the system, printer did not work. Customer did not print that they want.

   Z: Customer demands regarding to non-issues problems that could not be answered by our support team may cause customers reaction.

   T: Customers want to get support that does not include support service. They start to get angry when they learn that it is impossible to get a support regarding that issue.

   N: Customer cannot perform some transaction due to the lack of education regarding to system. They claim that the system do not include that transaction.

   K: Customer state that they are faced with many problems that are not solved so far.

2. When did this case happen?

   X: It happened on 11th of January, 2013.

   Y: It happened in 2012.

   Z: While keeping a guard.

   T: Date is not defined.

   N: It happened on 24th of June, 2015.

   K: It happened on 28th of September, 2014.

3. Under what circumstances the case happened?

X: It was not tested by me on time.

Y: It should have been tested before updating.

Z: Even the information was given to customer about the support issues; they want to identify the issues.

T: The entire customers think that their problems are the most important and urgent. They do not have an idea that we only have support services in specific issues. The issues should be determined in sales processes.

N: It was because that the customer was not fully informed about the system that we sold them. It was not totally explained by our sales department.

K: Vast majority of problems that the customers are faced with emerge from user error. However, they do not want to understand the reason behind problems.

4. How was the customer response?

X: It was natural that we did not feel good. It was effected our relation between us.

Y: There was a tense environment because of the problem.

Z: Generally, they want to classify their problems as a top urgent issue. They mention that it affects the system.

T: Customer that cannot get support start to get angry.

N: Customer said that if the problem is not solved, they do not want to use the system anymore.

K: Customer respond was very despondent.

5. What were the effects that made you satisfied or dissatisfied?

X: Version transition was completed in a period. Actually, it was because Access point configuration. To sum up, it was a bad day even it was because of side effects.

Y: While everything was going well, problem that has been faced at a final stage causes the process to be longer.

Z: Especially, the situation causes effort losses in busy day. If the necessary information is given in a short period, it shortens the process.

T: Absence of information related to support services make customer dissatisfied. Unnecessary tensions make us dissatisfied and decrease our motivation.

N: Customer behavior changed after explaining everything clearly. We state that the problem occurred because of lack of information.

K: Both of side was satisfied at the end of the day as there was no problem to be solved. I felt happy.