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JOINT APPLIED PROJECT REPORT

AN ANALYSIS OF LEAN SIX SIGMA IN THE ARMY, NAVY AND AIR FORCE

September 2018

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The purpose of this Joint Applied Project is to analyze the application of Lean Six Sigma (LSS) within the Department of Defense (DoD), and more specifically, to provide successful examples from the Army, Navy, and Air Force using LSS. This research project discusses and analyzes each of the examples from those military branches and compares them to the Lean Six Sigma Principles.

Through the data that was analyzed, it was found that all three military branches have done a good job in implementing LSS. During this research and analysis, we found that even though the military branches said everything was going well, that it did not necessarily mean everything was fine. It was very difficult to find any data that mentioned negative aspects or things that could have been done differently when implementing Lean Six Sigma.

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AN ANALYSIS OF LEAN SIX SIGMA IN THE ARMY, NAVY AND AIR FORCE

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TABLE OF CONTENTS

I. INTRODUCTION....1
- A. BACKGROUND....1
- B. PURPOSE....2
- C. RESEARCH QUESTIONS....2
- D. SCOPE AND LIMITATIONS....2
- E. METHODOLOGY....3

II. LITERATURE REVIEW....5
- A. DEPARTMENT OF DEFENSE OVERVIEW....5
- B. LEAN THINKING....6
  - 1. Lean Thinking Definition....6
  - 2. Lean Thinking History....7
  - 3. Lean Thinking Principles....8
- C. SIX SIGMA....11
  - 1. Six Sigma Definition....11
  - 2. Six Sigma History....11
  - 3. Six Sigma Methodology....12
- D. LEAN SIX SIGMA....15
  - 1. Lean Six Sigma Definition....15
  - 2. Lean Six Sigma History....16
  - 3. Lean Six Sigma Principles....16

III. DATA COLLECTED....19
- A. PRIMARY QUESTION....19
- B. SECONDARY QUESTIONS....23

IV. DATA ANALYSIS....25
- A PRIMARY QUESTION ANALYSIS....26
- B. SECONDARY QUESTIONS....29

V. CONCLUSION AND RECOMMENDATIONS....33
- A. CONCLUSION....33
- B. RESULTS....33
  - 1. The Army, Navy and Air Force Have Done a Good Job Using Lean Six Sigma....33
  - 2. There Will Always Be Challenges When Facing the Change That Comes from Using Lean Six Sigma....34

C. RECOMMENDATIONS FOR FURTHER RESEARCH 34

LIST OF REFERENCES 37

INITIAL DISTRIBUTION LIST 41

LIST OF FIGURES

Figure 1. The Five Traditional Steps in Collecting Research. Source: Texas AHEC East (n.d.). 4

Figure 2. Department of Defense Organizational Chart. Source: "DoD Organization" (n.d.). 6

Figure 3. Lean Thinking History. Source: Lean Management Institute of India (2017). 8

Figure 4. Lean Thinking Principles. Source: Lean Enterprise Institute. (n.d.a). 9

Figure 5. Six Sigma DMAIC methodology. Source: Villanova University (2015). 13

Figure 6. What is Lean Six Sigma. Source: Go Lean Six Sigma. (n.d.). 16

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LIST OF ACRONYMS AND ABBREVIATIONS

AL&T	Acquisition, Logistics, and Technology
AMC	Army Materiel Command
BGT	Brigade Combat Team
CONUS	Continental United States
CPI	Continuous Process Improvement
DFSS	Design for Six Sigma
DFLSS	Design for Lean Six Sigma
DMAIC	Define, Measure, Analyze, Improve, Control performance
DoD	Department of Defense
FY	Fiscal Year
GDP	Gross Domestic Product
HMMWV	High Mobility Multipurpose Wheeled Vehicle
LSS	Lean Six Sigma
MAIC	Measure, Analyze, Improve, Control
NMSC	Navy Medicine Support Command
TPS	Toyota Production System

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I. INTRODUCTION

A. BACKGROUND

When you hear the term "Lean Six Sigma," (LSS) you may wonder what it is and what companies, including the military, are using it. "LSS has been used for many years in businesses and organizations throughout the world, from Motorola to Boeing and Amazon, as a means to cut waste and save money" ("List of Lean Six Sigma companies," n.d). "LSS is a managerial approach that "combines Six Sigma methods and tools and the Lean Thinking principles, striving to eliminate waste" (Six Sigma, n.d.) "It takes us out of our comfort zone and makes us look at things from a different perspective" (Wales, 2011). In recent years, organizations around the world have started implementing LSS as a means to cut waste and save money.

In 2009, the Department of Defense (DoD), deployed Lean Six Sigma throughout its organizations (under the DoD Instruction for Implementation of CPI/LSS program, dated July 17, 2009). The DoD is the largest employer in the world, employing over 1.3 million men and women on active duty and 742,000 civilian personnel. In addition to the active duty and civilian personnel, there are an additional 826,000 serving in the National Guard and Reserve forces (Department of Defense [DoD], n.d.). This was considered one of the largest undertakings ever experienced.

Being a large employer in the public sector makes their daily business structure a little different than the private sector. Change, whether good or bad, is something that is faced daily within the DoD, but today, the DoD is facing a very different outlook. There are continuous conflicts, engagements and requirements that demand a response, such as The Gulf War, Operation Enduring Freedom and Operation Iraqi Freedom (Eaglen, 2015) All of this is a tremendous challenge for the U.S. Army, Navy and Air Force, which are part of the DoD. The Secretary of Defense has recognized the need for process improvement and in 2008 issued a directive to all DoD components to use Lean Six Sigma (Sicilia, 2008).

B. PURPOSE

The purpose of Joint Applied Project is to analyze how the military used LSS and if its successes experienced can be replicated throughout the DoD. with a focus on the Army, Navy and Air Force and what they individually have done to implement Lean Six Sigma and if there were any opportunities to implement LSS that were not being used.

C. RESEARCH QUESTIONS

The primary focus of this research is:

1. Can the successes noted in these researched LSS projects be replicated within DoD?

The secondary focus of this research paper answers the following questions:

1. Are there opportunities to implement LSS that are not being considered?
2. What were some of the challenges faced by the Army, Navy and Air Force and what did they do to overcome them?

D. SCOPE AND LIMITATIONS

The scope and focus of this project is on the use of Lean Six Sigma within the Army, Navy and Air Force. To gain a better understanding of what the impact has been from using LSS, this project will evaluate 9 examples of installations successfully using LSS to save time and money. These examples will include the Army HUMVEE production line at Red River Army Depot, the Corpus Christi Army Depot's reporting process and its repair line of the AH-64 Gun Turret Flanges. The Navy examples came from the Navy Medicine Support Command, which used Lean Six Sigma in their application process for new medical personnel. The Naval Hospital in Bremerton, Washington, used LSS to automate and streamline their medical records process and the cut down on wait times for patients getting immunizations. For the Air Force, examples are from the Aviano Air Force base where the two fighter squadrons used LSS to revamp their frontlines of their two fighter squadrons in order to do the same amount of work, but with more reasonable work hours and the 31st Fighter Wing egress shop at the Aviano base also successfully

implemented LSS on their final inspection line. The final example came from the 31st Medical Group, which used LSS in their procedure to process all the active duty medical and dental record requirements.

A comparative analysis has been performed on the collected data from these sites and compared to the principles of Lean Six Sigma. As with any research paper, there will be some limitations that will be faced, such as size of area studied, lack of time, distance from locations and funding. For this Joint Applied Project, a main limitation is the size of the areas from where the data was gathered. With this project focusing on the three branches of the military made its way to large and almost impossible to obtain all the proper research, thus the reason to narrow the search to three examples each mentioned earlier. Another limitation that may be faced will be hard to get 100% of the truth when regarding things that could have been done differently. This can have an impact in regard to the scope of this project because we will not be able to a true look at if using LSS has helped or hurt the Army, Navy and Air Force.

E. METHODOLOGY

The data for this project has been collected from multiple sites to include Internet articles, papers and books. The data will be gathered from installations, depots and other sites within the U.S. Army, Navy and the Air Force and will then be compared to the LSS principles used by companies throughout the world. In addition, the data collection process for this project will also follow the five traditional steps for collecting research as shown in Figure 1.

Figure 1. The Five Traditional Steps in Collecting Research.
Source: Texas AHEC East (n.d.).

This project is divided into five chapters. Chapter I provides the purpose for the research, presents a brief background of the situation, identifies the research questions, addresses the scope and any limitations regarding the research, as well as explains how the data for this research will be gathered. Chapter II gives an in depth background of the Department of Defense, Lean thinking and Six Sigma. Chapter III provides a brief overview of the data collected during this research paper, Chapter IV provides answers to the primary and secondary questions through an analysis of the data that was collected. Chapter V provides conclusions, recommendations, and opportunities for further research.

II. LITERATURE REVIEW

A. DEPARTMENT OF DEFENSE OVERVIEW

The organization of the Department of Defense is large and there are many different departments and operations that all have an impact when using LSS. Within these departments and operations, the leadership plays a key role in the successful implementation of Lean Six Sigma. Without the support of the leadership in the DoD the impact could turn out differently. For this reason it is important to have a brief understanding and knowledge of how the DoD's departments are organized, see Figure 2.

"The Department of Defense is located at the Pentagon in Washington, DC, and its mission is to provide the military forces needed to deter war and to protect the security of the United States" (U.S. Department of Defense [DoD], n.d.). Everything done within the Department of Defense is to support the military forces and their missions. "The DoD is an organization larger than the top five Fortune 500 companies combined, with a $518 billion budget that would rank as the 16th largest gross domestic product (GDP) in the world. The DoD employs about five million people in 140 countries" (Sicilia, 2010).

The President of the United States is, of course, the Commander-in-Chief of the Armed Forces. The Secretary of Defense reports directly to the President. The Chairman of the Joint Chiefs of Staff reports to the Secretary of Defense and the President. The nine Combatant Commanders each report to the Chairman of the Joint Chief of Staff. The DoD is divided into three different military departments: Army, Navy, and Air Force. The Department of the Navy comprises two Services, the Navy and the Marine Corps. These military departments have specific missions, including their own senior civilian leaders (the Service Secretaries), and military leaders (Chief of Staff of the Army, Chief of Naval Operations, Commandant of the Marine Corps, and Chief of Staff of the Air Force). The military departments each have their various major and subordinate commands located across the globe, of which many report to the various Combatant Commander. In addition to the military departments, the DoD has seventeen agencies and ten field activities (DoD, n.d.).

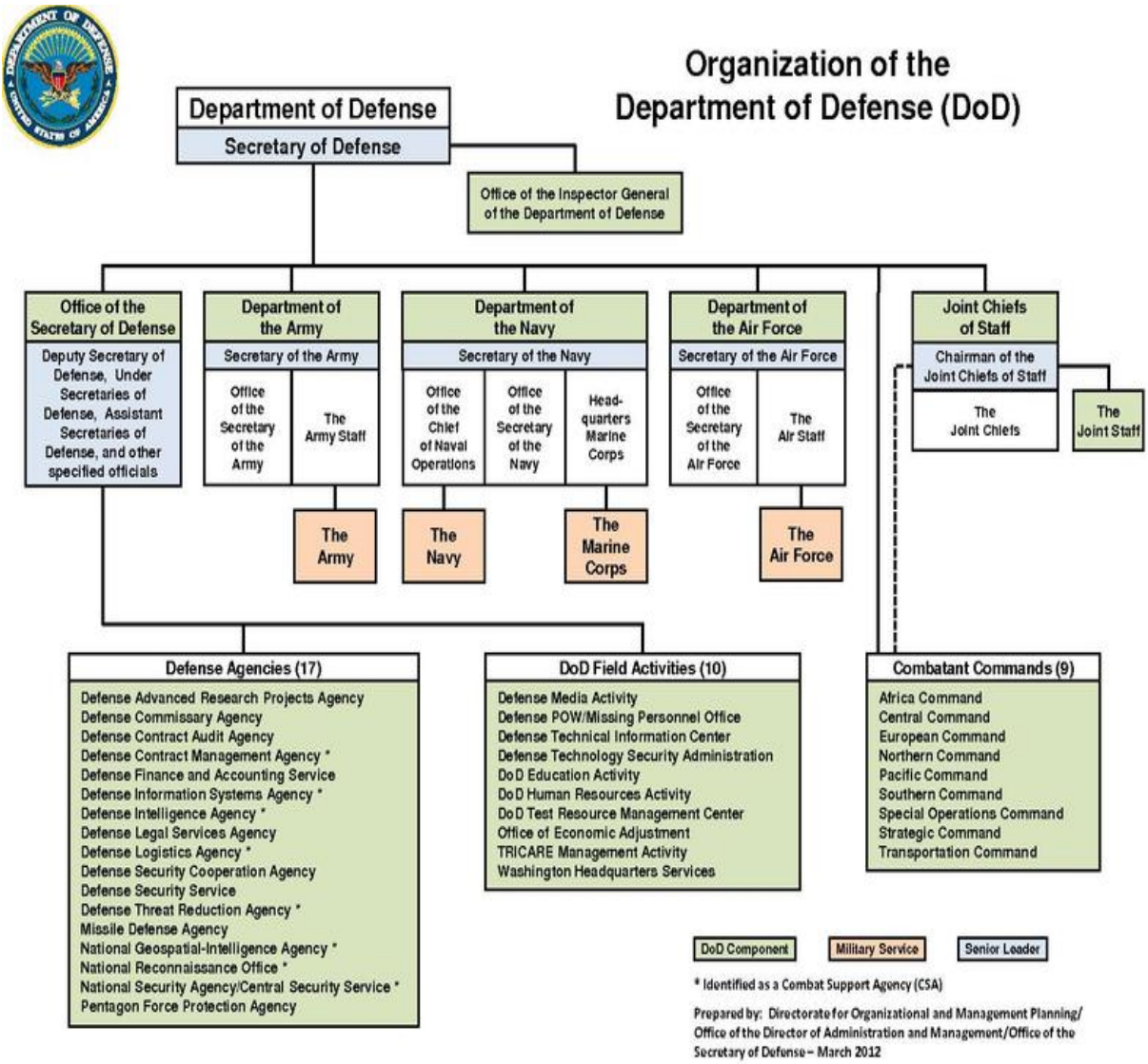

Figure 2. Department of Defense Organizational Chart.
Source: "DoD Organization" (n.d.).

B. LEAN THINKING

1. Lean Thinking Definition

Lean Six Sigma is a compilation of Lean Thinking and Six Sigma. In this section the definition, history and principles of Lean Thinking will be discussed. In future sections the same information will be discussed in regards to Six Sigma and Lean Six Sigma.

"Lean is a philosophy that, when appropriately applied to a process, reduces or eliminates the expenditure of unnecessary time, materials, and effort" (Hart, 2006). Lean Thinking is not only used in production and manufacturing, but it can apply across every business. "The core idea of Lean Thinking is to maximize customer value while minimizing waste. In other words Lean Thinking means creating more value for customers with fewer resources" (Lean Enterprise Institute, n.d.b). In the book, *Lean Thinking,* by James P. Womack and Daniel T. Jones, the authors say that Lean Thinking allows companies to "specify value, line up value creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively" (Womack & Jones, 1996, p. 15). Their research also shows that "Lean is about doing more with less. Lean thinking is about improving the process, resulting in increased efficiency, lower cost, and higher quality for the customer" (Womack & Jones, 1996, p. 15).

2. Lean Thinking History

The first person who used something similar to the lean process was Henry Ford. In 1913 Ford created what he called flow production in which he interchanged parts with standard work and moving conveyance. This was something that had never been seen before, but there were still some issues that Ford could not fix, such as providing variety (Texas AHEC East, n.d). Figure 3 describes a brief history of Lean and who was involved with the beginnings of Lean.

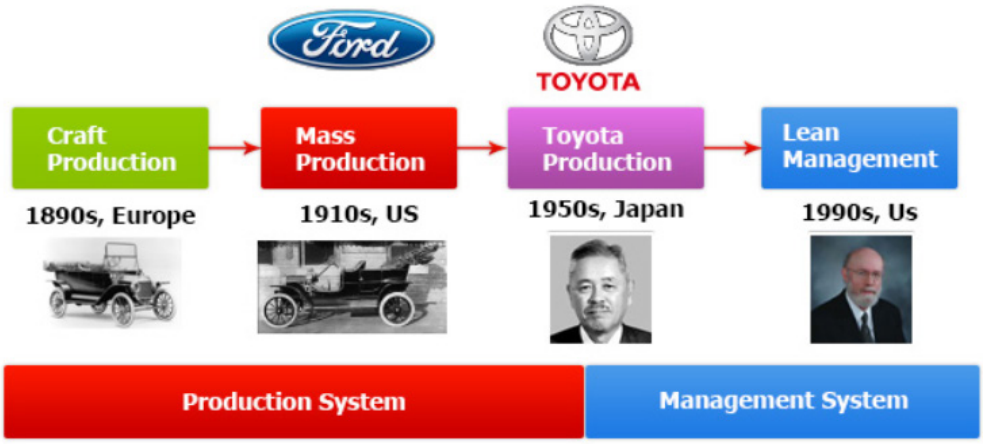

Figure 3. Lean Thinking History. Source: Lean Management Institute of India (2017).

After World War II, a group from Toyota expanded on Henry Ford's original experience with the flow production. Those at Toyota soon realized that if they were to make a few simple innovations that it would be possible to provide consistency continuity in the work completed, thus creating the beginnings of the Toyota Production System (TPS) (Texas AHEC East, n.d). Toyota took the TPS and shifted the focus from individual machine utilization to the flow of the product throughout the total process. TPS was the foundation for what today is called lean thinking (Texas AHEC East, n.d). Today Lean Thinking has successfully been used worldwide by many government and private sector organizations.

3. Lean Thinking Principles

In their book *Lean Thinking,* Womack and Jones explain more in detail about the principles of Lean Thinking. When implementing Lean Thinking processes into the daily work environment there are five principles used; see Figure 4.

Figure 4. Lean Thinking Principles. Source: Lean Enterprise Institute. (n.d.a).

a. Identify Value

Womack and Jones (1996) defined value as a "capability provided to customer at the right time at the appropriate price, as defined in each case by the customer" (p. 311). This is the starting point for Lean Thinking as defined by the customer. "By clearly defining value for a specific product or service from the end customer's perspective, all the non-value activities - or waste - can be targeted for removal" (Principles of Lean, n.d.).

b. Map the Value Stream

Lean Thinking defines the value stream as the set of all the "specific activities required to design, order, and provide a specific product, from concept to launch, order to delivery, and raw materials into the hands of the customer" (Womack & Jones, 1996, p. 311). "This represents the end-to-end process that delivers the value to the customer. Once you understand what your customer wants the next step is to identify how you are delivering (or not) that to them" (Go Lean Six Sigma, n.d.).

c. Create Flow

Creating flow is defined by Womack and Jones (1996) as the "progressive achievement of tasks along the value stream so that a product proceeds from design to launch, order to delivery and raw materials into the hands of the customer with no stoppages, scrap or backflows" (p. 306). In order to achieve this flow, the business or organization need to get rid of steps that are no longer needed. By doing this, the customer will receive the needed product at the needed time. (Go Lean Six Sigma, n.d.).

d. Establish Pull

Establishing pull is the fourth principle of Lean Thinking. Womack and Jones (1996) define this principle as a "system of cascading production and delivery instructions from downstream to upstream in which nothing is produced by the upstream supplier until the downstream customer signals a need" (p. 309). In the article, "Five Phases of Lean Six Sigma," it states that this principle is about "understanding the customer's demand service and then activating the process to respond the customer's demand. In this way the producer or service provider delivers only what the customer wants when the customer wants it" (Go Lean Six Sigma, n.d.).

e. Seek Perfection

Womack and Jones (1996) state that "as value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, begin the process again and continue it until a state of perfection is reached in which perfect value is created with no waste" (p. 308). Perfection is defined by the authors as the "complete elimination of muda so that all activities along your value stream create value" (Womack & Jones, 1996, p. 308). As all the previous steps occur, "the gains become significant and all the steps link together. More and more layers of waste become visible and the process continues towards the theoretical end point of perfection, where every asset and every action adds value for the end customer" (Master of Project Academy, n.d.).

In the article, The Five Phases of Lean Six Sigma, it states that when these principles, are followed and implemented, it will help any organization or business (Go Lean Six Sigma, n.d.). The article continues to state that

> by following these five lean principles a producer or provider will implement a philosophy that will become just the way things are done, thus ensuring that you are driving towards the overall organisational strategy by constant review of your processes to ensure that they are constantly and consistently delivering value to your customer. This allows the organization to maintain its high level of service whilst being able to grow and flex with a changing environment and it does this through implementing sustainable change. (Go Lean Six Sigma, n.d.).

C. SIX SIGMA

1. Six Sigma Definition

> Six Sigma is a management philosophy originated at Motorola that emphasizes setting extremely high objectives, collecting data, and analyzing the results to a fine degree as a way to reduce defects in products and services. The philosophy behind Six Sigma is that if you measure how many defects are in a process, you can figure out how to systematically eliminate them by establishing controls that keep process performance within a very narrow range compared to the design tolerances of the product or service. (Rouse, 2009)

Six Sigma, according to a *Wikipedia* article, says that it is a set of strategies, techniques, and tools for process improvement, and is a "disciplined, data-driven approach and methodology for eliminating defects in any process – from manufacturing to transactional and from product to service" ("Six Sigma, n.d.).

2. Six Sigma History

Throughout the years many have thought that Six Sigma was a statistical term, but today that knowledge has changed to much more, thanks in part to Bill Smith. (The Evolution of Six Sigma, 2017). Bill Smith was an engineer who worked for Motorola and wrote an internal quality research report, which caught the attention of Bob Galvin, Motorola CEO. Smith, along with Mikel Harry used the concept of "logic filter" to develop the early road map of Six Sigma. In the article, "The Evolution of Six Sigma," it says that Smith and Harry "developed a four-stage problem-solving approach: Measure, Analyze,

Improve, and Control (MAIC)" (The Evolution of Six Sigma, 2017). In 1987, now Chairman Bob Galvin launched a new corporate program, called "The Six Sigma Quality Program" establishing Six Sigma as the required capability level (The Evolution of Six Sigma, 2017). "Six Sigma helped Motorola realize powerful bottom-line results in their organization – in fact, they documented more than $16 Billion in savings as a result of our Six Sigma efforts" (Go Lean Six Sigma, n.d.), but the Six Sigma process was not done changing and evolving into what it is today.

Over the next ten years, Mikel Harry worked with multiple other businesses helping them implement the Six Sigma processes.

> It was in 1988, while at Unisys Corporation. Harry discussed with Cliff Ames, one of Unisys' plant managers, about how to leverage the Six Sigma technique throughout an organization and how to recognize the people who were equipped with Six Sigma tools. Since Ames was a lover of karate and Harry himself was a martial arts enthusiast, in some respects, they shared the same Eastern martial arts philosophy. People in martial arts are incredibly skilled, have a precise command of tools, are very dedicated, and are very humble to learn. Based on this insight, Harry decided to designate those with Six Sigma skills as Black Belt. (The Evolution of Six Sigma, 2017)

It was not until late 1993 that Six Sigma really began to transform businesses and businesses started to adopt Six Sigma into the daily operations.

"Since then, tens of thousands of companies around the world have adopted Six Sigma as a way of doing business. This is a direct result of many of America's leaders openly praising the benefits of Six Sigma. Six Sigma has evolved over time" (Six Sigma, 2016). In the article, "The History of Six Sigma," it mentions that Six Sigma is "more than just a quality system like Total Quality Management (TQM)." The article continues to say that "Six Sigma is many things, and it would perhaps be easier to list all the things that Six Sigma quality is not. Six Sigma can be seen as: a vision; a philosophy; a symbol; a metric; a goal; a methodology" (Six Sigma, 2016).

3. Six Sigma Methodology

"A main objective of the Six Sigma methodology is the implementation of a measurement-based strategy that focuses on process improvements and variation reduction

throughout the application of a project" (What is Six Sigma, n.d.). This methodology is used by organizations to improve the effectiveness and efficiency of organizational processes across an industry. As organizations use this process, it becomes a powerful tool to lean their businesses to stronger performance standards, streamline resources and clarify business goals. DMAIC is an acronym indicating Six Sigma guidelines used to define, measure, analyze, improve, control performance, see Figure 5.

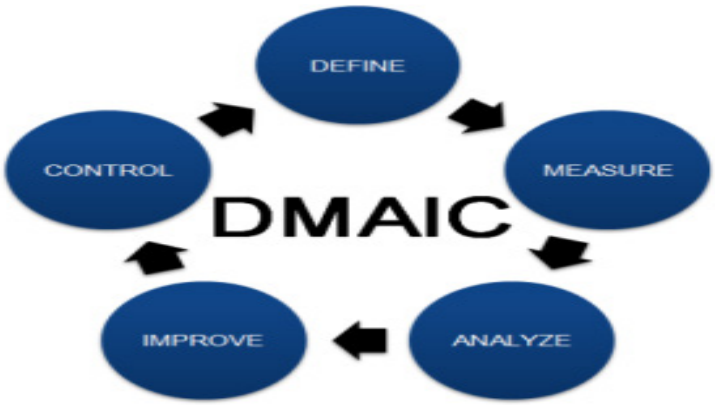

Figure 5. Six Sigma DMAIC methodology. Source: Villanova University (2015).

a. Define

The main objective of the first stage of the Six Sigma methodology is to define the problem. Leaders will determine what needs to be fixed and the parameters that will define the project. This stage is also where the customer needs and requirements are aligned with the goals of the project. It is a critical time where team development occurs and the project begins to take shape.

b. Measure

The goal of the second stage is to measure how the process currently performs and to collect data that is important to the scope of the project. This stage is critical throughout the whole process. The team will collect the data to compare against future results. It is also important in this stage to begin to focus on and understand the root cause of the

process. This stage takes a lot of time and effort, so it should be started in the early stages of the project.

c. Analyze

During the third stage of the Six Sigma methodology process, the objective is to analyze the data collected in the previous stage and to identify the causes of the defects. Team members will want to know what the data is telling them. As the data collected and analyzed, the root cause of a business inefficiencies will be verified, along with areas where the implementation of change can provide the best results. This stage, at times, is often intertwined with the second stage.

d. Improve

The goal of the improvement stage is to find out how you will fix the problem or the root cause of what was identified in the Analyze stage. In this stage, team members' main effort is to find as many solutions as possible to the problems identified in previous stages. Brainstorming solutions is one way that might find solutions to fix the problems. Once the team members are satisfied, or cannot come up with any other possible solutions, the best solution is chosen. There will be times when multiple solutions are the answer to the problems found earlier. This is also where a map needs to be developed of the different possible solutions. At the end of this stage another main focus is to complete a test run of a change that is to be implemented. By doing this the team members can finalize any potential changes.

e. Control

In the final stage of the Six Sigma methodology process, the objective is to understand how to sustain the newly achieved improvement. Metrics can be developed to help leaders monitor and document the success of the improvement. There is no time frame for completing this stage since these strategies and solutions stated earlier are ongoing and adjustments can be made. A key to the success of any implementation of change is to make sure the process is being managed and monitored properly. To increase the success of any

change, it is recommended that organizations apply new knowledge to other areas and to celebrate successes (Villanova University, 2015).

D. LEAN SIX SIGMA

1. Lean Six Sigma Definition

In the article What is Lean Six Sigma, it says that it is "a managerial approach that combines Six Sigma methods and tools and the Lean Thinking principles, striving to eliminate waste of physical resources, time, effort and talent, while assuring quality production and organizational processes." The article continues to say that "Lean Six Sigma provides a means to improve the delivery of products or services using a disciplined project-based approach." The article also states that "Lean Thinking and Six Sigma complement each other. Lean Thinking accelerates Six Sigma, delivering greater results than what would typically be achieved by Lean or Six Sigma individually" (What is Lean Six Sigma. n.d.). "The primary differences arise in prioritizing which project initiatives are to be adopted, data collection and data analysis" (Wilhite, 2018).

"The two initiatives work together, achieving results consistently superior to what either system could achieve alone.… A combination of both provides the tools to create ongoing business improvements" (Smith, 2003). Michael George, author of the 2002 book *Lean Six Sigma: Combining Six Sigma with Lean Speed* said that "*Lean Six Sigma* shows how Lean and Six Sigma methods complement and reinforce each other. It also provides a detailed road map of implementation so you can start seeing significant returns in less than a year" (George, 2002).

As stated earlier, Lean Six Sigma is a compilation of Lean Thinking and Six Sigma, see Figure 6. "Lean Six Sigma engages the entire company in efforts to create a culture of learning and continuous improvement" (Sessoms, 2015).

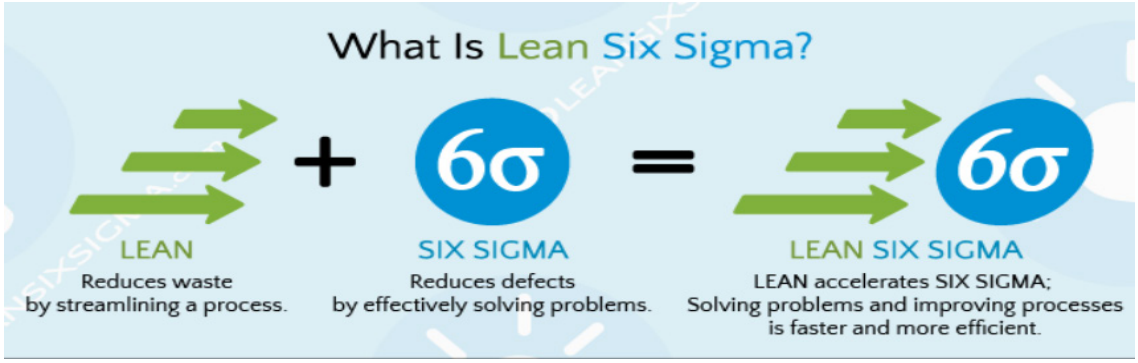

Figure 6. What is Lean Six Sigma.
Source: Go Lean Six Sigma. (n.d.).

2. Lean Six Sigma History

The technique of Lean Six Sigma has many similarities to both Lean Thinking and Six Sigma, but it must be managed differently, because the goals are different, as are the metrics for measuring success. The book, *Lean Six Sigma: Combining Six Sigma with Lean Speed,* discusses what Lean Six Sigma is and how the same statistical principles apply to Lean Six Sigma and Six Sigma (Wilhite, 2018). In the article from Morgan it states that

> Lean Six Sigma was strongly used when computers were not as common as they are in today's workforce. In the 1980s, both the techniques of Lean and Six Sigma were taught in training. Lean is still focused on getting the customer ever closer to exactly what they really want, which entails removal of waste, but it is not a main principle of lean. Six Sigma is not just about improving quality; rather, it is controlling variability which saves money, with the by-product of improved product or service quality. After 2002, an official combination of the two techniques was the now called Lean Six Sigma. (Morgan, 2009)

3. Lean Six Sigma Principles

According to Michael George, Lean Six Sigma first emphasizes the use of Lean methodologies and tools to further satisfy the customer by identifying and removing waste (making the product a better value). The article continues by saying that "increasing process velocity (to more precisely meet the customer's delivery date), then follows that with the use of Six Sigma methodologies and tools to identify and reduce or remove process variation which will improve efficiency and increase profit" (George, 2002, Preface).

When implementing Lean Six Sigma, following are some of the key principles of Lean Six Sigma to keep in mind:

a. Make Sure You Focus on the Customer

When implementing LSS, focusing on the customer is the most important principle to follow. For any change, it should be the primary goal of the business or department to deliver a change that will provide a maximum benefit to the customer. Another important part of this principle is to remember that you work for the customer, not vice versa.

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b. Make Sure You Can Identify and Understand How the Work Is Getting Done

You need to know what the problem is and how it can be fixed. As the problem is identified, this principle helps those involved remember the importance of understanding what problem is actually being worked on and the steps involved to get it done. It is always easy in situations like this for those involved to get caught up in continually changing things, but one needs to concentrate on the areas that is in their particular department. Trying to change something that is outside their department may cause the LSS process to stall or take a longer time than expected.

c. Where You Can, Improve the Process Flow

Now a problem has been identified it is important to take a good look at the process or flow of this new LSS project. "Making it a smoother process will improve the process from start to finish which will save time and money" (Lean Enterprise Institute, n.d.a).

d. If There Are Steps You Find That Are of No Value, Remove Them

Along with principle 3, this one also has a focus on the flow of a process. In order to save time and money a lot of time needs to be spent on the steps in the process that is being looked at. Bottlenecks in a process is something that has no value and is important that it be removed as early as possible. Also at this time ways to decrease defects should be looked at and streamlined. This is one way have quality control and efficiency.

e. Involve the People That Are Already Part of the Process

Along with principle 1 of LSS, involving those who are already apart of the process is a good way to get the needed support throughout the LSS process. Communication is another important point to remember throughout the whole process. As those involved in the LSS process communicate with those already involved in the process, the likelihood of a successful outcome increases. Also for those involved need to be equipped with the tools and training will help to have a smoothly run program.

f. When Making Improvements, Do So in a Systematic Way Rather Than All At Once

Finally, it is important to keep in mind throughout this process to be flexible and responsive. Change and LSS often go hand in hand, which can be painful at times, but it is worth the end outcome of a leaner, stronger and more competitive process. By remaining flexible to change in a systematic way will, in the end, cause fewer kinks in the stages (Lean Enterprise Institute, n.d.a).

III. DATA COLLECTED

A. PRIMARY QUESTION

(1) Can the Successes Noted in These Researched LSS Projects Be Replicated within the DoD?

The U.S. Army

In 2006, the Red River Army Depot in Texarkana, Texas, implemented Lean Six Sigma and by so doing has decreased the time it takes to rebuild battle damaged Humvees with creating a new assembly-line process. Some of the changes made to the new assembly-line process were to use a "time managed intervals to control the flow of work, organizing employees based one experience and proficiency and stocking more and better quality of parts" (Brown, 2012).

In 2004, Red River was only rebuilding about 3 Humvees a week. After implementing LSS principles, and the changes mentioned earlier, Red River is now rebuilding an average of 32 mission – ready Humvees a day. As a result of Red River Army depot using the Lean Six Sigma process the cost to repair one Humvee vehicle has decreased from $89,000 to $48,000, thus saving a total of $30 million. (Army AL&T Jan. 07) and a few years later the depot is now able to repair 40 vehicles per day. How did they do this? Former Red River Commander Col. Doyle Lassiter said in2012: "This cannot happen by just one section, one division or one branch being successful," said Lassiter as he spoke to the first shift employees. "This can only happen if everyone across the depot works together. We appreciate very much your dedication to duty. It is tremendously hard what you do and you make it look easy." He continues, saying, "achieving 40 vehicles per day is a great testimony to the flexibility of our workforce," said Lassitter. "The nation benefits from this because we can take a vehicle and extend its life expectancy at a reduced cost to buying a new vehicle. It's a cost savings to the Department of Defense and to our taxpayers" (Brown, 2012).

In 2015 the Corpus Christi Army Depot implemented LSS in their processes and received two of the ten 2015 Army Lean Six Sigma Excellence Awards at a ceremony held

at the Pentagon. The first project Corpus Christi did was focused on improving the internal Product Quality Deficiency Reporting Process. Through using LSS in this process, this team was able to standardize the roles, responsibilities and performance requirements within the entire process. This helped to improve the reporting accuracy and visibility to 98% and reduce revenue losses by 90%. This resulted in a cost benefit that saved the Army more than $7 million over the following three years.

The second award that Corpus Christie Army Depot won when they used LSS focused on how to save time and money in the repairing of AH-64 Gun Turret Flanges. When they received a damaged gun mount that took a long time to repair, they realized something had to change. With that in mind a second team set about to find a solution to this process using LSS, which ended up being 545 days faster and saving the depot $9.2 million in costs. (Rox, 2016).

The U.S. Navy

The Navy Medicine Support Command introduced Lean Six Sigma into their process for bringing in new medical personnel into the Navy. In so doing they reduced the process for completing applications, thus saving the Navy money. Originally the department was spending about 64 days to complete one application to bring in new medical personnel into the Navy. This process, on average, received more than 300 applications annually. The process included verifying that the credentials were accurate and true and that the medical personnel would make a good fit for the Navy. After implementing Lean Six Sigma into this process the average time to complete an application went down to about 24 days.

The personnel involved in implementing Lean Six Sigma said that this new process helped them to identify certain areas where existing methodology could improve. LSS helped the department simplify the process, which would insure the right people joined the Navy and that the top-notch service continued. The NMSC use of LSS, they have realize two things. First of all that using LSS does save time and money for the Navy and DoD. Secondly, NMSC learned that by fixing issues in their processes has created a more focused

work environment where all involved can benefit from the changes made. (Navy Medicine Support Command Public Affairs, 2011).

Another LSS example comes from the Naval Hospital in Bremerton Washington in June 2017. A group of sailors got together and implemented LSS process in the Medical Records Department by creating the Medical Records Data Automation Program, which automates and streamlines medical records department. The department maintains about 55,000 medical records of patients who receive treatment and ensures the records are all up to date with the proper medical history and data. During the process those sailors involved realized that many of the tasks in the current process could be automated and that is how the Medical Records Data Automation Program was created. The end result was a benefit to the Naval Hospital and the patients as well and has let to improvements in both cost and time. Before the implementing of LSS it took about 30–45 days to get request medical information, but thanks to LSS they are now able to get those request met in minutes. The LSS process also helped the medical records department save $156,400 a year and conserve over 7,300 man hours a year. It also helped to reduce the department's workload by 40%. (Jiang, n.d.)

This same Naval Hospital in Bremerton Washington had another success story the previous year. In December 2016 another group of sailors developed a new process using LSS principles. This time their focus was to reduce the wait times for patients getting immunizations the military members, while also reducing the staff needs for immunization along with reducing the needed paperwork for the whole process. Prior to the use of LSS in the immunization process on Induction Day for the military members would involve long lines, delays and a lot more red tape to go through. Petty Officer 3rd Class Kayla Kirk, along with the other sailors had a significant impact on the overall process through using the LSS principles, they were able to decrease the steps taken by the medical personnel by 79%. In addition this improved immunization process helped the process time by 75 percent for the vaccinations of about 1,200 new military members. Ms. Kirk said:

> What we did to improve the process was use data from previous years to discover where we could cut back and organize to save money on not only unnecessary vaccines, but hourly wages by cutting down time immensely…. My team and I spent long hours mapping out our goals and

> strategies and arranging our ideas, as well as screening immunization forms and transcribing into the students medical records…. When it came time to put our well-thought-out process to the test, we took a few days to set up and get ready for show time. Everything ended up running smooth. (Stutz, 2016)

The U.S. Air Force

The Aviano Air Base used the Lean Six Sigma principles to revamp the frontlines of their two fighter squadrons. After implementing LSS, the Air Force realized that they would be able to do the same amount of work, but with more reasonable work hours. Before Lean Six Sigma was introduced the maintenance personnel at Aviano worked 12 hour days to complete the mission. Throughout the LSS process, the Air Force decided to consolidate functions and have the same maintenance personnel work for both squadrons. By doing this the average work day dropped from 12 hours to 8.5-9 hours, which benefits the personnel and their families (U.S. Air Force, 2008). Another example from Aviano Air Base comes from the 31st Fighter Wing. Here the Airmen in the F-16 Fighting Falcon egress shop implemented LSS on the final inspection line. Prior to implementing LSS, when items, like ejections seats, would reach the final 7-level inspection they would always have multiple writ-ups, delays and rework. After LSS the new inspection system has now produced more fully mission capable items with less maintenance issues. By taking a look at the steps involved in the final inspection process, these Airmen from the 31st Fighter Wing, created a new lean process that has helped build the confidence with the piolets in the jets.

The 31st Medical Group also took a look at their current processes to see if LSS could help them improve their current procedures. The 31st Medical Group currently had to process all the active duty medical and dental requirements and through applying LSS they were able to complete all the requirements in under two hours, saving 24,000 man hours each year. Another benefit for the Air Force experienced from the 31st Medical Group process improvement was a reduced amount of errors and saving more than 22,000 miles of travel a year. (Ritter, 2008)

B. SECONDARY QUESTIONS

(1) Are there opportunities to implement LSS that are not being considered?

This is a hard question to answer because, as stated earlier, many offices do not have anything written down about what went wrong or what they could do better. For this reason many employees are left to use their own personal experiences with Lean Six Sigma. In many of the offices within the military that I have been in a common occurrence kept happening, I would randomly see an email about the few LSS opportunities and ask if I could participate in a LSS opportunity. Afterwards, nothing else would be said about Lean Six Sigma or other opportunities to work with it. Come to find out that the current process to get onto a LSS team is hard and there is only a small local team that decides who can participate and what potential projects will be worked on. From this experience I now notice that a missed opportunity is to continually get the word out, in a variety of ways, to the employees about LSS opportunities. Most DoD employees have heard of Lean Six Sigma, but many are not given the opportunity to be on a LSS team or get the needed training. If you look at the number of military bases in the United States and abroad, which is nearly 800, and then add to that list the additional DoD civilian buildings, military Arsenals and Depots, this is a lot of civilian and military workers who could be involved in finding ways to implement Lean Six Sigma and in the process save the DoD money. (Vine, 2015)

(2) What were some of the challenges faced by the Army, Navy and Air Force what did they do to overcome them?

The Department of Defense has had a lot of success when using Lean Six Sigma in the military, but challenges have happened and continue to happen in every branch of the military. The list of challenges can be long, but many fall into two categories of communication and fear.

Communication is a very broad topic, but when dealing with LSS challenges it comes down to the communication between upper management and their employees. Many times this may also involve upper management that lack the commitment to LSS. This can cause their employees to loose opportunity to participate in a LSS project. The

communication challenge can also mean some don't understand the LSS process and methodologies.

Fear is another main challenge faced when using Lean Six Sigma. When deciding to use the LSS principles in your daily processes can cause some change to happen. Regardless if it is good or bad change, this makes many fear the impending change. Another part of fear is letting it block the LSS vision and that some change is needed. (Herbert, 2008)

IV. DATA ANALYSIS

In this chapter, a comparative analysis will be performed on the results of the data that has been gathered from the three LSS examples from the Army, Navy and Air Force. The top findings from each military branch will be listed along with a brief summary and will then be compared to the principles of LSS, which are listed in the following sections. Since Lean Six Sigma is a combination of Six Sigma and Lean Thinking, this comparative analysis will only use the principles not the DMAIC steps (Lean Enterprise Institute, n.d.a.).

(1) Make sure you focus on the customer.

When implementing LSS, focusing on the customer is the most important principle to follow. For any change, it should be the primary goal of the business or department to deliver a change that will provide a maximum benefit to the customer. Another important part of this principle is to remember that you work for the customer, not vice versa.

(2) Make sure you can identify and understand how the work is getting done.

You need to know what the problem is and how it can be fixed. As the problem is identified, this principle helps those involved remember the importance of understanding what problem is actually being worked on and the steps involved to get it done. It is always easy in situations like this for those involved to get caught up in continually changing things, but one needs to concentrate on the areas that is in their particular department. Trying to change something that is outside their department may cause the LSS process to stall or take a longer time than expected.

(3) Where you can, improve the process flow.

Now a problem has been identified it is important to take a good look at the process or flow of this new LSS project. "Making it a smoother process will improve the process from start to finish which will save time and money" (Lean Enterprise Institute, n.d.a.).

(4) If there are steps you find that are of no value, remove them.

Along with principle 3, this one also has a focus on the flow of a process. In order to save time and money a lot of time needs to be spent on the steps in the process that is being looked at. Bottlenecks in a process is something that has now value and is important that it be removed as early as possible. Also at this time ways to decrease defects should be looked at and streamlined. This is one way have quality control and efficiency.

(5) Involve the people that are already part of the process.

Along with principle 1 of LSS, involving those who are already apart of the process is a good way to get the needed support throughout the LSS process. Communication is another important point to remember throughout the whole process. As those involved in the LSS process communicate with those already involved in the process, the likelihood of a successful outcome increases. Also for those involved need to be equipped with the tools and training will help to have a smoothly run program.

(6) When making improvements, do so in a systematic way rather than all at once.

Finally, it is important to keep in mind throughout this process to be flexible and responsive. Change and Lean Six Sigma often go hand in hand, which can be painful at times, but is worth the end outcome of a leaner, stronger and more competitive process. By remaining flexible to change in a systematic way will, in the end, cause fewer kinks in the stages (Lean Enterprise Institute, n.d.a.).

A PRIMARY QUESTION ANALYSIS

- Can the successes noted in these researched LSS projects be replicated within DoD?

After completing a comparative analysis on these three military branches and comparing their experiences using LSS, the data showed that each branch has had success using Lean Six Sigma in their processes. The question still remains on if the successes experience in these 9 researched examples can be replicated within the DoD, the answer is Yes. From the very beginning of the implementation of LSS in the DoD it has been

supported throughout the organization. Knowing this, organizations in the DoD can use the 4 main steps learned through this research when deciding to use Lean Six Sigma in their areas.

1. First, someone realized a process needed to be changed

As mentioned in the data section, this step was normally the first to happen when deciding to use Lean Six Sigma. Change and Lean Six Sigma go hand in hand, the data showed that in each of the 9 examples, change always came when a location decided to use LSS. The research noted that this change can be hard for everyone involved, but that it is worth it. For those involved in the LSS process the data also noted that it was important to figure out the main problem that needed to be changed and not to get so focused on changing everything, which could lead to a failed LSS project. This change could be for a simple process or large procedure, but the key was that one person or a group of people needed to notice that a change was needed.

- Lean Six Sigma Principles

The analysis showed that as a change was noted and the true problem found, the team involved in this process used the 3, 4, and 6 LSS principles during this step. These principles included focusing on where they could improve the process, make it smoother, eliminate unneeded steps and not doing anything drastic. These military branches involved in this research did this by taking the time to notice a change was needed and that it could be a good change.

2. Second, there was a plan

The planning part of LSS is one of the most important steps to having a successfully ran program. The research showed that each example took the time to figure out a good plan before continuing with other LSS principles. Making a plan for a successful program takes time. In the data gathered the second example from the Bremerton Naval Hospital showed the sailors involved in finding a solution to the delays, long waits and increased cost took their time.

The analysis showed that in this second step that each branch knew that this plan would include long hours to decide on possible goals and strategies. Also key to successfully implementing LSS was to involve the right people. The research showed that those who were the leaders of the of the LSS group realized that having the right people could either make or break the success of the program. The earlier the right people were involved in this group the better the group ran and the early the planning process in order to correctly gather and analyze the data.

- Lean Six Sigma Principles

In this second step of having a plan, the LSS teams tended to follow LSS principles 2, 3, 4, and 6. These LSS principles state that it is important to identify and understand how the work will get done, ways to improve the process to save money or time, and again not to do anything drastic. The research showed that the Army, Navy and Air Force accomplished this by getting the right people involved at the right time.

3. Third, they took a look

This was another important step to remember when deciding to use LSS. In the examples that were researched, the analysis showed that is where the Army, Navy and Air Force's methods were very similar. Each branch individually took a look at two things when deciding to use LSS. First they took a look at their previous year's data and the second thing they each did was to take a look at their current processes and procedures. The analysis clearly shows that when a military site with the Army, Navy and Air Force decided that Lean Six Sigma was the correct choice for them that the results were a success.

The data gathered from these examples also show that a key factor when they took a look at their current procedures was to be flexible and focusing on maximizing the potential benefit for the customer. When the customer can see the savings they are more likely to help in different ways. The successes or benefits experienced by each branch were normally an increase of confidence among employees, a decrease of costs for parts and hours worked without sacrificing the particular mission.

- Lean Six Sigma Principles

The LSS principles that were followed as groups took a look at their processes and procedures were LSS principles 3 and 4. These LSS principles show the importance, as previously stated, that you need to take the time to identify processes from start to finish that could help improve the flow, save time and money, while also finding and identifying unneeded steps.

4. Fourth, multiple people were involved in the process

As mentioned earlier, the individual installations knew the importance of having the right people to be involved in the whole process, which normally meant using as many of the people currently involved in the process as possible. As the individual sites continued to work on using LSS, this last step is an important one. The analysis performed showed multiple times that Lean Six Sigma helped in a variety of ways, such as increasing the confidence in the employees to finish the jobs or helping the employees to spend more time with their families, while continuing to finish the job on time using less hours. The data showed that making the recognition that changing a process or procedure to use LSS did not involve just one person, but it was each employee.

- Lean Six Sigma Principles

Finally, the last step used by the Army, Navy and Air Force when using LSS was to notice and involve all the people who participated in this process. For the LSS principles, this can be compared with steps 1 and 5. These state that it is important to focus on the customer and to involve everyone that are already a part of the process. The military branches did this by noticing that implementing LSS is not a one person job, but it includes everyone on the floor and those behind the scenes.

B. SECONDARY QUESTIONS

1. Are there opportunities to implement LSS that are not being considered?

The analysis of the data for this question proved harder to find than expected. Even with this research project having a small sample size, it was hard to find any articles that

showed a particular site within the Army, Navy or the Air Force where they actually admitted to that something went wrong when using LSS or that an opportunity was missed. One would have to use personal experiences to answer this question. As stated in the data chapter I experienced I would randomly see an email about the few LSS opportunities and ask if I could participate in a LSS opportunity. Afterwards, nothing else would be said about Lean Six Sigma or other opportunities to work with it. Come to find out that the current process to get onto a LSS team is hard and there is only a small local team that decides who can participate and what potential projects will be worked on. From this experience I now notice that a missed opportunity is to continually get the word out, in a variety of ways, to the employees about LSS opportunities. Most DoD employees have heard of Lean Six Sigma, but many are not given the opportunity to be on a LSS team or get the needed training. If you look at the number of military bases in the United States and abroad, which is nearly 800, and then add to that list the additional DoD civilian buildings, military Arsenals and Depots, this is a lot of civilian and military workers who could be involved in finding ways to implement Lean Six Sigma and in the process save the DoD money (Vine, 2015).

- Lean Six Sigma Principles

Comparing this question to the principles of LSS showed that even though there was no definitive data found that any principle can be used when identifying opportunities that could have been done differently.

2. What were some of the challenges faced by the Army, Navy and Air Force what did they do to overcome them?

Along with the prior question, this too is a hard one to find a concrete answer because there are always challenges faced, but they are not always noted to the public. The analysis for this question came done to making sure that employees knew more about LSS and that the lines of communication were better. Also employees and management need to give Lean Six Sigma a chance. By doing this, those employees and management will see its value and know that change can be good and everyone can fully support the future changes when using LSS.

- Lean Six Sigma Principles

For this question all the 6 steps can be used when identifying challenges. A quote from Michael Mulhern, the maintenance officer aboard Nimitz said, "We're not making any changes to the end product, we're changing the way you get to the end product. If we can save a Sailor an hour out of the day, that's an hour they get back. If you can minimize the time spent walking from point 'A' to point 'B' to get a part, that means we're getting that part through the system a bit quicker, that means we're saving unnecessary travel for the Sailor, we're saving wasted steps. So I think in the long run, it's a way to improve their processes" (Johnson, 2017).

3. How did the different military branches overcome these obstacles faced when using LSS?

To overcome the challenges regarding implementing LSS is vast, but one thing that the research showed helped at different military locations is to be able to let the employees see the LSS process in action. By doing this, those employees and management will see its value and know that change can be good. By allowing those employees who are interested in the LSS process to see it in action can help in many ways. First of all, once they see the benefits they can become a trusted ally in future implementing of LSS. They can also help get other employees around them excited about using LSS and its potential benefits.

As noted in the article Does Six Sigma Need to Have the Support of Upper Management, it says that when dealing with the upper management, "they will never fully support Lean Six Sigma if they view it as taking away from their resources rather than adding capability and helping them become more successful in achieving their goals; nor will they actively support it if they think it is eating up vital budgetary allotments rather than setting the stage for significant financial payback" (Peterka, 2013).

Those who are not 100% knowledgeable about LSS can remember to give it a chance. This may be easier said than done. The research that was gathered for this paper did not clearly show the opinions of the employees who face the changes brought by LSS. It did show that when more people are involved in the LSS process that employees are

more willing to give it a chance. Michael Mulhern, the maintenance officer aboard Nimitz said,

> We're not making any changes to the end product, we're changing the way you get to the end product. If we can save a Sailor an hour out of the day, that's an hour they get back. If you can minimize the time spent walking from point "A" to point "B" to get a part, that means we're getting that part through the system a bit quicker, that means we're saving unnecessary travel for the Sailor, we're saving wasted steps. So I think in the long run, it's a way to improve their processes. (Johnson, 2017)

V. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

President Obama said, "We cannot meet the challenges of today with old habits and stale thinking" (Obama, 2009). In a world that is always changing, the Army, Navy and Air Force have a large responsibility to defend the United States. The analysis of the data that was gathered showed that each branch followed the Lean Six Sigma principles when implementing it into their processes and procedures. Through the hard work of those involved on the LSS teams they each found multiple processes and procedures that were in need of improvement and the end results where well worth the challenges that were faced. In each example researched the data showed that not just the locations benefited from using LSS, but customers, patients and the taxpayer all benefited from the changes brought on by LSS. This methodology is used by organizations to improve the effectiveness and efficiency of organizational processes across an industry. As organizations continue to use this process, it will become a powerful tool to lean their businesses to stronger performance standards, streamline resources and clarify business goals.

B. RESULTS

1. The Army, Navy and Air Force Have Done a Good Job Using Lean Six Sigma

In each of the examples researched, all branches have learned the benefits of using LSS. Each branch now have a specific office dedicated to finding projects to use LSS more frequently. Through consistently using LSS money has been saved, work hours have decrease while still completing the mission, and many processes have been streamlined. The key is to continue to get the word out to all the employees, both civilian and military about future opportunities. Once people learn the value of using LSS it will help them learn how to organize and have a new perspective on how to improve the day-to-day operations (Lewis, 2017).

2. There Will Always Be Challenges When Facing the Change That Comes from Using Lean Six Sigma

As previously stated, choosing to use LSS can be challenging, but a key noted through this research and analysis was that communication is crucial when implementing LSS. This communication is with all levels of management along with other employees. Management need to be more fully involved in letting their employees know when LSS opportunities are available. Letting their employees see the LSS process in action will help them know the importance and value that Lean Six Sigma has and the change for good it provides.

As noted in the article Does Six Sigma Need to Have the Support of Upper Management, it says that when dealing with the upper management, "they will never fully support Lean Six Sigma if they view it as taking away from their resources rather than adding capability and helping them become more successful in achieving their goals; nor will they actively support it if they think it is eating up vital budgetary allotments rather than setting the stage for significant financial payback" (Peterka, 2013). "Effective communication requires more than an exchange of information. When done right, communication fosters understanding, strengthens relationships, improves teamwork, and builds trust" (Papadopoulos, 2014).

C. RECOMMENDATIONS FOR FURTHER RESEARCH

Overall, the Army, Navy and the Air Force have done a great job when choosing to use Lean Six Sigma and the similar results prove that. One thing that can only help each branch to increase the positive results of using LSS is to improve the communication paths between those involved in choosing who can participate in LSS projects, management and their employees. A recommendation of a monthly email could be sent out to remind management of upcoming LSS opportunities, thus keeping the vision and importance in the minds of all the employees.

Implementing a new change like Lean Six Sigma is not easy. It's a work in progress. It will take time and results do not happen overnight and there will be many challenges and even more benefits. As stated by Maleyoff in 2007,

successfully applying LSS requires a long-term viewpoint that considers all stakeholders. The consistency of approach provided by Lean Six Sigma enhances the effectiveness of project teams and allows for the sharing of project results across the organization. Disciplined follow-up ensures that project team recommendations are implemented and tracked. But sustaining Lean Six Sigma requires a culture that actively supports process improvement in both words and actions. And the active commitment of leadership is a must. (Maleyoff, 2007)

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