Lean Six Sigma Case Study within a Public School District

Ms. Emily M Salmon, Mississippi State University

Emily Salmon is a recent graduate of Mississippi State University (MSU) with a bachelor's in Industrial and Systems Engineering. She is a Research Engineer for MSU's Institute for Systems Engineering Research (ISER) located in Vicksburg, MS. Her current research involves lean six sigma practices and applications, manufacturability, and modeling and simulations. She received her Six Sigma Black Belt from MSU's CAVS Extension Center in June 2016 and is currently pursuing her Masters of Engineering at MSU.

Lean Six Sigma Case Study within a Public School District

Abstract

A primary focus of a systems engineer is defining customer needs, defining functionality of a system early in the development, recording system requirements, and then creating a design and plan of action along with validation of the system. Imbedded in this definition is the need for continuous improvement for the system, and business practices in question, no matter the environment. Systems engineering efforts can be improved by using lean six-sigma methodologies and tools through understanding customers, defining processes, and interpreting data. The Vicksburg Warren School District saw a need for improvement due to the lack of systems engineering process and principles in their business administrative practices specific to the Career and Technical department. The problems consisted of a lack of organization, understanding, and clarity of organizational processes. This department was not performing and operated through disorganized, non-communicating people and systems. This was especially concerning in light of the desire for the school district to be selected as one of Ford Next Generation Learning's (NGL) communities. The superintendent expressed a desire to see a system engineering approach applied to the improvement of this department in preparation for Ford's arrival. This research sought to understand the whole system, expose lean six-sigma tools to a new audience and gauge the receptiveness of each tool before beginning with recommendations. It included observing the process and problems of the career and technical director's department and determining best practices for the education and implementation of lean six-sigma tools in preparation for the start of the Ford NGL program. The define, measure, analyze, improve, control (DMAIC) process was used to expose the everyday activities and areas for improvement within the department. Several tools were utilized and, once introduced to the director, were given a trial run to determine which were effective and which either were not effective, or needed more instruction. Finally, a list of tools referred to as "best practices" were combined and formally put into a user handbook for the department's use. This handbook illustrates the most effective lean six-sigma tools from the research, and provides step-by-step instructions on how to use them. The outcome of this research prompted the restructuring of the department and the creation of a new position. This paper will provide the methods used and explanations given, results found from this project and explain why a complete lean six-sigma project is not feasible for this type of environment.

Introduction

According to a 2007 Industry Week Magazine Survey, 70% of US companies are using some type of continuous improvement program (Lean, Six Sigma, Total Quality Management, etc.) but only 9% report good results, and less than 25% are satisfied with their current program. Some of the primary reasons for failure, during the implantation stages, are a lack of leadership support, failure to tie activities to financial results, and the company's lack of a clear vision of the operating model. These programs are becoming more popular in non-manufacturing environments, specifically the service industry, healthcare and government organizations. However, can a complete, true to form Lean or Six-Sigma approach be effective in such environments, when they were originally created for manufacturing processes? This paper will

discuss what is Lean Six-Sigma, definitions of Lean and Six-Sigma tools, provide the methods used for improvement recommendations and results, ”best practices” found from this project, and explain why a complete lean six-sigma project is not feasible for this type of environment.

The Vicksburg Warren School District (VWSD), located in Warren County Mississippi, has not received satisfactory state testing scores for the past several years. In an effort to improve the ratings, a new superintendent was hired and several new programs were implemented. One such endeavor was attracting the Ford Next Generation Learning (NGL) Institute to select Vicksburg Warren School District as one of their academy style learning communities. Ford Next Generation Learning is a collaborative community driven approach to achieve the following outcomes: increased community, prosperity shared by all, a strengthened talent pipeline, young people prepared for college, careers, lifelong learning, and leadership, educational equity and justice for all, and the capacity to contribute and go further. The superintendent expressed a desire to see a system engineering approach applied towards the improvement of business practices within the career and technical department in preparation for Ford’s arrival. The school district saw a need for improvement due to the lack of systems engineering process and principles in this department. The problems consisted of a lack or organization, understanding, and clarity of organizational processes. This department were not performing well and operated through disorganized, un-communicating people and processes. This was especially concerning in light of the desire for the school district to be selected as one of Ford NGL’s communities.

Ford NGL is a unique and comprehensive community initiate that brings together educators, employers, and community leaders to implement a proven model for transforming secondary schools, which ultimately improves the regional workforce development system. They support a growing number of communities that are committed to expanding and strengthening their networks of transformed secondary schools. Career and interest-themed academies serve as the Ford NGL practice model for transforming the secondary school experience. They recognize that most skilled employment now requires a foundation of academic, 21st century, and technical knowledge and skills that must be mastered in high school, a well as additional education beyond high school. They believe that the most successful approach for high schools is one that infuses the high expectations and academic rigor of college preparatory academic programs with the real-world relevance and rigor of career and technical education. Their approach can be carried out through academies, which take several forms, including multiple career academies and other themed programs within a large school, single-themed schools, and early-college high schools.

The Institute of Systems Engineering Research (ISER) is a department of Mississippi State University and is located at the Engineering Research and Development Center’s (ERDC) Information Technology Lab in Vicksburg, MS. Its mission is to develop solutions for unique systems engineering problems and facilitate the extraction of technology solutions from federally funded research labs to meet industrial business needs in the commercial world. ISER was contacted to give suggestions and exposure to systems engineering concepts, and lean six-sigma methodology and tools to aid in the preparation for Ford NGL. After much collaboration between Ford NGL and the school administrators, academy style learning was decided as the best fit for improving the high schools and increasing the state scores. However, to be successful, the school district needed some guidance.

Initial Research

Having just completed a black belt six sigma training class, I was very familiar with the concepts and tools that make up a lean six-sigma project. This project would be more of a challenge because of its untraditional environment. In my online search for examples of other's who had tried to accomplish similar tasks I found some success story examples. The state of Indiana has started using workshops to educate high school teachers about six sigma using slideshows, hands-on-activities, and field trips to industry to show the effects and rewards of lean six-sigma in practice. These examples of process improvement are very inspiring for teachers whose "products" are the students and their abilities to perform as adults. These workshops also encourage discussion about the significant adaptation required to overcome educational hurdles. Some of these hurdles include success measurement and what is feasible to measure performance by; since student achievement can take 10, 20, or even 30 years to capture, and financial benefits become tricky in non-profit education systems. The author felt that none of the hurdles were insurmountable and that it was time for lean six-sigma in education. The University of Michigan also conducted a study looking at lean six-sigma as a way to improve the quality of higher education institution practices. They focused on SIPOC (supplier, input, process, output, and customer), cause and effect analysis, and FMEA (failure mode and effects analysis) to find ways to help in the development of sustainable higher quality educational processes. Their findings indicated that after the identification of the issues and defining the problems, a solution could be developed using these approaches. Finally, an article written about using six sigma practices to solve problems in the classroom gave some valuable insights. Every teacher in a high school in Colorado received a copy of the book The Six Sigma Way as a holiday present. The objective was to apply this approach to the entire school district. The article details how they started with the simplest applications to build enthusiasm and confidence in the methodology and immediately improved the heating/ventilation of the buildings, ordering materials, and lawn and building maintenance. More challenging areas, such as curriculum, required much more input and involvement from teachers and staff. The final results were successful and showed that lean six-sigma was able to change areas that everyone agreed needed serious overhauling. With these success stores I felt confident that introducing lean six-sigma tools would be beneficial to the improvement of the school's business practices, however, I was still skeptical of how well a traditional lean six-sigma project approach would work.

Methodology

A primary focus of a systems engineer is defining customer needs, defining functionality of a system early in the development, recording system requirements, and then creating a design and plan of action along with validation of the system. Imbedded in this definition is the need for continuous improvement for the system, and business practices in question, no matter the environment. Systems engineering efforts can be improved by using lean six sigma methodologies and tools through understanding customers, defining processes, and interpreting data. Because of the step-by-step approach to improving a system that lean six sigma tools gives, this was the direction chosen to pursue to begin ISER's relationship with VWSD. This research sought to understand the whole system, expose lean six-sigma tools to a new audience and gauge the receptiveness of each tool before beginning with recommendations. It included observing the

process and problems of the career and technical director's department and determining best practices for the education and implementation of lean six-sigma tools in preparation for the start of the Ford NGL program. The DMAIC process was used to expose the everyday activities and areas for improvement within the department. Several tools were utilized and, once introduced to the director, were given a trial run to determine which were effective and which either were not effective, or needed more instruction.

Exposure to new terms, methodologies and engineering tools proved to be a challenge for the school district's departments. Along with initial research into the department's processes and defining problem areas, the department needed introduction materials describing the basics of lean six-sigma.

Lean is a production practice that aims to minimize waste along a process or within an organization. It holds to the ideology that any use or storage of resources that does not deliver customer value is considered waste and should be eliminated. Lean originates from Toyota and the Toyota Production System. Any truly lean system is very dependent on what its customers needs are and how reliable its suppliers are. Lean is the systematic identification and elimination of waste, the implementation of continuous flow of products or people, and customer demand. Five areas drive lean: cost, quality, delivery, safety and morale. Every system that contains waste can have lean concepts applied to it.

Six-Sigma is an overall business improvement system that is built around the understanding of a customer's requirements and is driven by the execution of carefully selected projects supported by a handful of powerful analytical tools. The goal of six-sigma is to find and eliminate causes of mistakes in a business process, reduce variation and know what is important to the customer. This methodology originates from Motorola developed as a key business initiative in 1987. The Greek letter Sigma when followed by the word "level," measures the capability of the process to perform defect free work. The higher the sigma level, the better the quality of a product or service with a defect being anything that does not result in customer satisfaction. Sigma is a statistical term that refers to the standard deviation of a process about its mean. Motorola's objective was to reduce variability through continuous improvement and to obtain customer satisfaction. Traditional Six-Sigma projects are designed for manufacturing processes that used a data-driven methodology for decision-making and process improvement based on business and customer values. A project creates a cultural change in the working environment, which is driven by three major elements:

1. Voice of the customer
    a. Find and focus on the customer as a source of process quality
2. Business Cases
    a. Understand the business reasons for process and change
3. Decision Making with Empirical Data
    a. Use data to drive decisions

Six-Sigma projects can be done with two different approaches, both resulting in the same goal but using different tools and steps. The first is to improve existing products and processes and the second to develop a new product and process. Both approaches require a deep commitment

from the highest levels of management and a tolerance for endlessly questioning the validity of the company's beliefs and traditional ways "things are done around here." The goals of a traditional Six-Sigma program are: deficiency reduction, yield improvement, customer satisfaction, and higher net income.

Six-Sigma is a journey, not a destination. Some themes of Six-Sigma include: a genuine focus on the customer, data and fact driven management, process focus (continuous improvement), boundary-less collaboration and tolerance for failure.

Both Lean and Six-Sigma look at the company as a whole to recognize problematic areas of business, define improvements and implements data driven solutions in a predictable and repeatable way. These highly structured strategies for acquiring, assessing and applying customer intelligence for improvement are very similar in nature and are very commonly used in parallel. Lean tools are used to improve the speed of the process while six-sigma is used to improve the accuracy.

The career and technical department is responsible for the oversight of new projects and it was very clear that systems engineering and lean six-sigma tools would be helpful for project management and improvement activities. For Six-Sigma to be effective there must be processes in place that must be brought into control statistically, and must be improved by reduction of variation. An implementation strategy is also required needing: top management support and participation, project identification, resource allocation, data based decision making and measurement, and feedback. The process of implementing six-sigma must be a top down approach. Responsibility must lie with senior management and they drive the process through the organization. Elements of this include: careful selection of projects, allocation of resources, and decisions based on the measurements. Senior leadership establishes its Six-Sigma vision, customer satisfaction promise, goal, and new measurement indices. Leaders of successful Six-Sigma implementations make this a top priority. They devote enormous amounts of thought, energy, time and personal resources to making sure the Six-Sigma succeeds while also challenging their employees.

Tools Used

The most commonly used process for implementing a Six Sigma project is the DMAIC process. DMAIC is an acronym for Define, Measure, Analyze, Improve and Control. The DMAIC method was initially used to map out what needed to happen to be prepared for Ford NGL. Several tools within each of these steps were introduced for potential use along with a detailed handbook outlining how the tools work and to what purpose they are useful. The research identified 29 common tools that could be effective for use in this environment as detailed in the tables below.

1. **Define**

Tools	Definition	Outcome with VWSD
SMART Analysis	The acronym SMART is an outline used for project management and personal development. The five elements are directed at achieving company goals are: • Specific: the specific targeted area for improvement • Measurable: quantify an indication of improvement progress • Assignable: Indicate the responsible individual or team • Realistic: state realistic results using available resources • Time-related: specify when the results can be achieved	Successful: visual, hands-on-activity, usable with qualitative data
SWOT Analysis	(Strengths, Weaknesses, Opportunities, Threats) This analysis is a way to clearly show a company's internal strengths and weaknesses, as well as their external opportunities and threats. A SWOT Analysis requires that a comprehensive appraisal of internal and external situations be undertaken before suitable strategic options can be determined.	Successful: visual, hands-on-activity, usable with qualitative data, interactive
PDCA Cycle	The PDCA cycle is a problem solving technique that is graphical and logical in most situations and is an open loop. P stands for plan, D for do, C or Check, and A for act.	Successful: visual, qualitative data
Work Breakdown Structure	The WBS expands the project into a detailed listing of activities • Each activity should be broken down into smaller activities until the level is reached in which each element is under one identifiable individual responsibility • Each activity is assigned a duration Time constrained projects are assumed to have unlimited resources to make sure on-time completion is possible	Successful: visual, qualitative data, assignable, applicable to free Google apps
Gantt Chart	A chart in which a series of horizontal lines shows the amount of work done or production completed in certain periods of time in relation to the amount planned for those periods. • Advantages include the charts are easy to understand, each bar represents a single activity, it is simple to change the chart, the chart can be constructed with minimal data, and program task progress versus date is shown. • Disadvantages include they do not show interdependencies of activities, the effects of early or late start of an activity are not shown, there is no means to indicate the variation in expected time to complete an activity, the details of an activity are not indicated, and there is little predictive value to this presentation	Successful: visual, qualitative data, assignable, applicable to free Google apps

	of data.	
SIPOC Analysis	(Supplier, Inputs, Process, Outputs, Customers) SIPOC is a tool that summarizes the inputs and outputs of a process. It uses a table form and is used for process improvement and definition phases. It identities all the important elements of a process before any work begins.	Initially Unsuccessful: complicated, required in-depth knowledge of system
PERT Chart	Pert is a program evaluation and review technique where all individual activities must be included in the network. Before an activity begins, previous activities must be completed and time estimates should be made for each activity; arrows do not indicate time to compete each activity. Critical path is a sequence of activities that requires the greatest amount of time. Network must begin and end with single events. ▪ Advantages of Pert include: the planning required to identify the task information for the network and the critical path analysis can identify interrelationships between tasks and problem areas, the probability of achieving the project deadlines can be determined, and by developing alternative plans, the likelihood of meeting the completion date is improved, changes in the project can be evaluated to determine their effects, a large amount of project data can be organized and presented in a diagram for use in decision making, and PERT can be used on unique, non-repetitive projects. ▪ Disadvantages of PERT include: the complexity of PERT increases implementation problems, and more data is required as network inputs.	Initially Unsuccessful: required quantitative data, complicated
Affinity Diagram	Affinity diagram is a technique that an individual or team can use for problem solving. It appears similar to the mind mapping technique and generates ideas that link up other ideas to form thought patterns. Affinity diagrams use an organized method to gather facts and ideas to form developed patterns of thought. The steps can be organized as following: define the problem; have notecards or post-it notes; enter ideas, data, facts, opinions, etc. on the cards or notes; place the cards on the wall or conference table; arrange the groups into similar thought patterns or categories; develop a main affinity category for each similar group of ideas; and once all the cards have been placed under an appropriate affinity category, borders can be drawn around each affinity group to complete the diagram.	Successful: hands-on-activity, visual, qualitative data, encourages new ideas and discourages bandwagon effect

Table 1. Define Tools

2. Measure

KASH Box Analysis	A KASH box is a tool, similar to a SWOT where K is knowledge, A is attitude, S is Skill, and H is habits. Management uses KASH Boxes to help identify areas where sustainable change can be done. This sustainable change is necessary in most cases for a project to be successful because a cultural or mind-set change within the employees is required. The purpose of a KASH box is to show that, more often than not, poor performance is not just an issue of knowledge and kills, but also includes poor attitudes and habits. Businesses spend their time and money developing the left half of the KASH box while most terminations are due to weakness in the right half of the KASH box	Successful: visual, qualitative data, hands-on-activity
Spaghetti Diagram	Spaghetti diagrams describe the flow of people, information or material in almost any type of process. Most applications consider people and the layout follows a traffic route as though an imaginary line of string were being deployed	Initially Unsuccessful: hard to find application
Trend Chart	A way that data is presented in either summary or time sequence and shows important elements of most processes changing over time. For many business activities, trend charts will show patterns that indicate if a process is running normally or whether desirable or undesirable changes are occurring	Initially Unsuccessful: complicated, required quantitative data
Process Mapping	Process mapping is a tool best used to identify the inputs, outputs, and other factors that can affect the process. It can depict the sequence of products, containers, paperwork, operator actions, or administrative procedures. It is often a starting point for process improvement teams. Flow charts are used to identify opportunities with these steps: ▪ Organize a team to examine the process ▪ Construct a flow chart to represent each process step ▪ Discuss and analyze each step in detail ▪ Ask the question "why do we do this?" ▪ Compare the actual process to an imagined "perfect" process ▪ Is there unnecessary complexity? ▪ Dos duplication or redundancies exist? ▪ Are there control pints to prevent errors or rejects? Should there be? ▪ Is this process being run the way it should? ▪ Improvement ideas may come from substantially different processes	Successful: Visual, hands-on-activity, qualitative data

Table 2. Measure Tools

3. Analyze

Brainstorming	Rules for brainstorming include: there are no dumb ideas; do not criticize other people's ideas; build on other people's ideas; and reverse the thought of "quality over quantity" meaning the more ideas the better and the quality of an idea is not as important at this phase.	Successful: Visual, hands-on-activity, qualitative data, encourages new ideas
Pareto Analysis	A Pareto analysis reflects the frequency or impact of problems. The actual analysis can appear either as a table or as a bar chart. It is a guide to selecting opportunities and prioritizing. The Pareto principle is derived from the 80-20 rule: 80% of the problems are due to 20% of the causes. It identifies problems to study, most likely causes, points out significant frequencies or costs, and is based on Joseph Juran's work (significant few and the trivial many).	Initially Unsuccessful: requires qualitative data, complicated
Pareto Chart	A Pareto chart is a type of chart that contains both bars and a line graph, where individual values are represented in descending order by bars and the line shows the cumulative total. It is a special type of histogram that will show frequency of an event happening. The Pareto principal is a principle named after the economist, Vilfredo Pareto, which specifies an unequal relationship between inputs and outputs. The principle states that for many common things within the natural world 20% of invested input is responsible for 80% of the result or output.	Initially Unsuccessful: requires qualitative data, complicated
Fishbone Diagram	Also known as a cause and effect diagram, the fishbone diagram is a team-based tool that determines the potential root causes of a problem. ▪ Breaks problems down into bite-size pieces ▪ Displays many possible causes in a graphical manner ▪ Shows how various causes interact ▪ Follows brainstorming rules when generating ideas	Successful: Visual, qualitative data
5 Why's Analysis	The 5 whys approach to root cause analysis is described as asking the question "Why?" five times. This technique is generally attributed to a Japanese method of determining the root cause of a problem.	Successful: interactive, qualitative data

Table 3. Analysis Tools

4. Improve

Cost Benefit Analysis	Project Cost benefit analysis is a comparison to determine if a project will be or was worthwhile. It is used as a management tool to determine if approval should be given.	Initially Unsuccessful: Required

	The sequence for performing a cost-benefit analysis are: ▪ Identify the project benefits ▪ Express the benefits in dollar amounts, timing and duration ▪ Identify the project cost factors including materials, labor, and resources. ▪ Estimate the cost factors in terms of dollar amounts and expenditure period ▪ Calculate the net project gain (loss) ▪ Decide if the project was beneficial	quantitative data, hard to implement in non-profit environment, similar to existing processes
Failure Modes and Effects Analysis	A FMEA provides the team a systematic technique to analyze a project for all potential or possible failure modes. The process steps are: ▪ FMEA number: this should be a log controlled number assigned by the team for tracking the document ▪ The process step name or description ▪ The design responsibility ▪ The date the FMEA was prepared ▪ The potential failure mode ▪ The potential effect of failure ▪ The potential cause of failure ▪ What are the current controls in place to prevent the cause from occurring?	Initially Unsuccessful: complicated, requires in-depth knowledge of causes of failure
Poka-Yoke	Shigeo Shingo is widely associated with a Japanese concept called Poka-Yoke, which means to mistake proof the process. He recognized that human error does not necessarily create resulting defects. A successful poka-yoke is to provide some intervention device to catch the mistake before it is translated into the product.	Initially Unsuccessful: hard to find application
Impact- Effort Matrix	An impact-effort matrix is a graphical way to show which activity is "low-hanging fruit" and can be solved with low impact and low effort.	Successful: visual, hands-on-activity, qualitative data
3 W's Action Plan	WWW (Who, What, When) Action plan ▪ What is a description of the tasks or action step ▪ Who is the individual responsible for completing the task and present to accept the assignment? ▪ When is the specific date – not a statement like two weeks, or within the month, etc.?	Successful: visual, hands-on-activity, qualitative data

Table 4. Improve Tools

Control

Standard Work/ Standard Operating Procedure	Standardized work is the documentation of each action required to complete a specified task and should always be displayed in the workplace.	Initially Unsuccessful: Required quantitative

		data, similar to existing processes
Control Plan and Chart/ Monitoring Plan	A control plan is a document describing the critical characteristics of the process. It is a monitoring system that ensures customer requirements are met and the process variation is reduced. Each part of the process must have a control plan.	Initially Unsuccessful: Required quantitative data, similar to existing processes
5S	Helps a company see problems Refers to the five Japanese words: seiri, seiton, seiso, seiketsu, and shitsuke which is shorthand expressions for the principle techniques of maintaining an effective, efficient workplace. The steps to 5S are: Sort, Set in Order, Shine, Standardize, and Sustain.	Initially Unsuccessful: similar to existing processes

Table 5. Control Tools

5. Project Meeting Tools

The standard meeting within a department could be described as the highest-ranking representative dominating the discussion while issues seem to shift and/or grow from different points of view. The agenda begins to creep, which stretches the meeting time and perhaps short circuits consensus building on action items. There is poor participation with little trust or commitment to the direction agreed upon by the group. In the end, the meeting becomes an undocumented and poorly interpreted waste of time. Meetings are necessary, but only through organization and a little effort are they effective. Some helpful tips for meetings include:

- Waiting seven seconds after asking a question to allow individuals time to comprehend and respond
- Using icebreakers. It may be chosen for its message or so members can learn something new about each other. If also can help to nudge "immovable" participants and improve the atmosphere of the meeting
- Establishing Ground Rules first:
  - Teams should reach a consensus on rules they are willing to honour. Discuss and be flexible
  - Revisions may be made at the facilitator's discretion with team consensus
  - Ground rules should remain active over the course of a team's life.
- Acknowledge the rules at the beginning of each meeting and address any need for revisions

Parking Lot Concept

Parking lot ideas and topics are written either on a flip chart or sheet of paper by the facilitator or designated scribe, whose role will be defined in next set of rules.

Successful Tools

Thinking of the department as a system where everything must work together and everything affects each other was critical during the project and understanding how DMAIC works. The tools used aided in understanding the systems thinking and enlightened the department of the interconnectedness of the system. Of the 27 common tools that are associated with Lean Six Sigma processes, 13 were implemented and utilized in the preparation of Ford NGL arrival. They included: SMART, SWOT, PDCA, WBS, Affinity Diagrams, KASH Box, Gantt Charts, Process Mapping, Brainstorming, Fishbone, 5 Whys, Impact – Effort Matrix, and Action Plan. All the tools that were adopted have similar characteristics. They all are visual, do not require as much quantitative data, can be accomplished easily in a group setting, and can be easily integrated into the current system. It was important to introduce tools that were easy to use both in understandability and incompatibility with the school district's current technologies. The district is a Google district and does not have readily available access to Microsoft products, which are the most common tools used for project management type activities. To fit this need, several free Google applications were researched and utilized that performed well and were very similar to common programs such as Visio, PowerPoint, and Project. Both the WBS, shown in figure 1 and Affinity Diagram were very beneficial in the initial stages of the project showing exactly what all was to be accomplished, and how to organize information effectively. These tools were created using the free Google application DrawIO that provided several pre-made templates for many of the successful tools used.

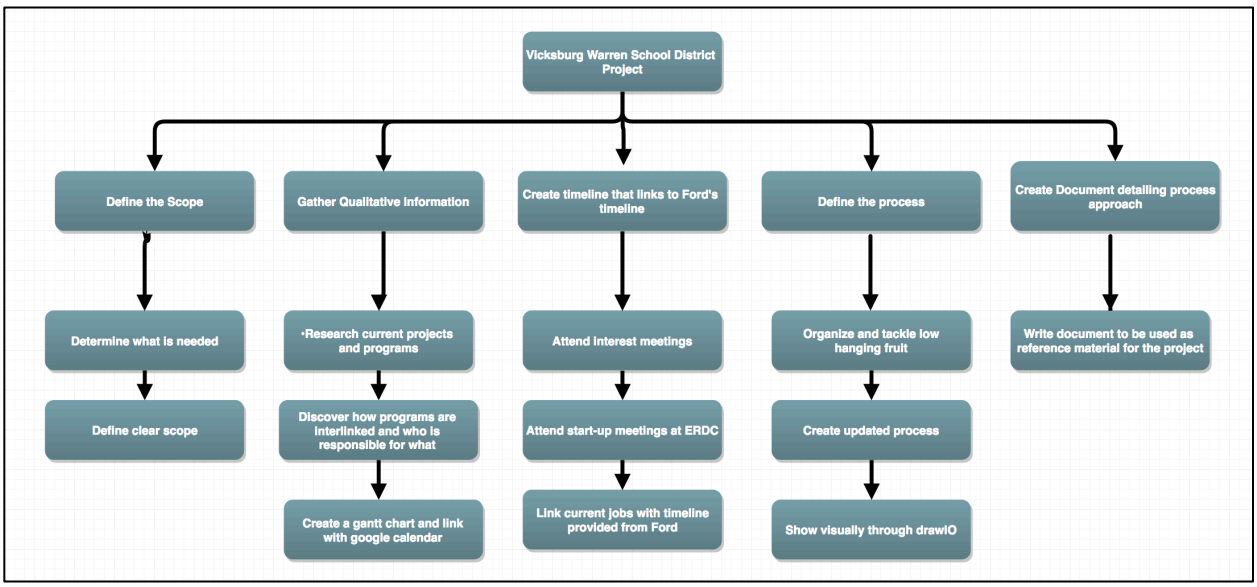

Fig. 1. WBS

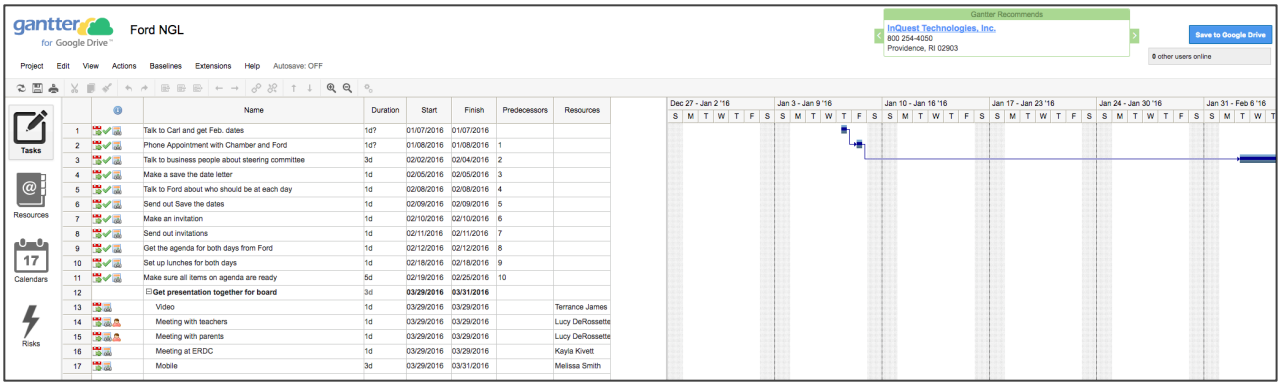

Fig. 2. Gantt Chart

The KASH box showed that poor performance is also about attitudes and habits. This activity brought to light some negative attitudes that could hinder the smooth implementation of the academies. The Gantt chart, shown in figure 2, using the free Google Drive application Gantter, was successful not only in the project management aspect, but also as an example of how these tools are available online for free, and can be seamlessly integrated into the already existing software infrastructure. Another example of tools being created with a free Google app is the fish bone diagram shown in figure 3. The tools that focused on people were easiest to comprehend, and the visual aspects of the tools were the most effective.

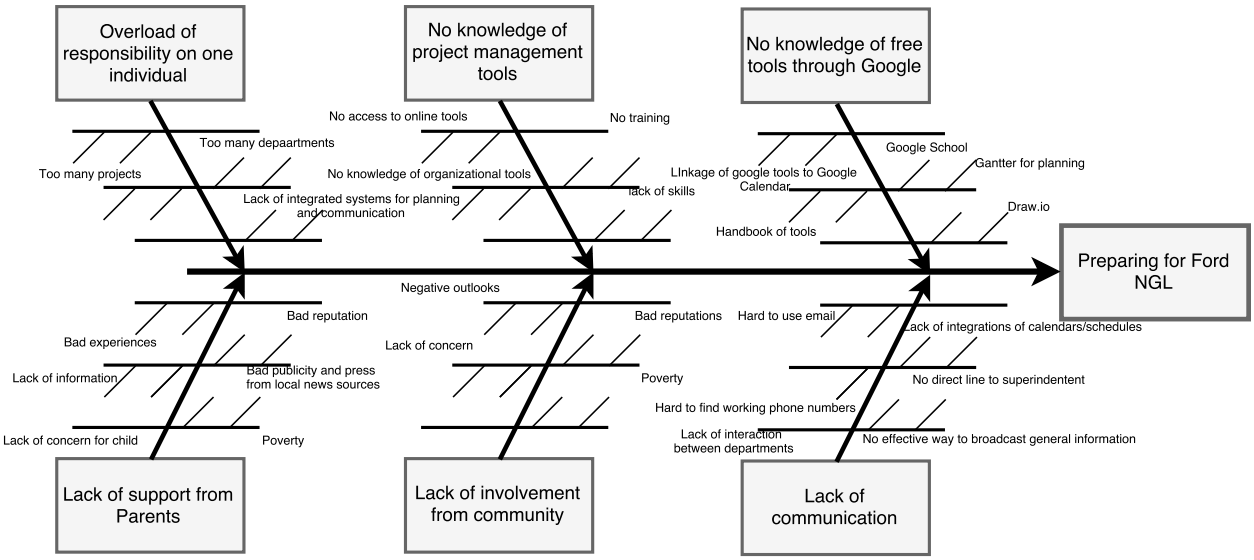

Fig. 3. Fishbone Diagram

Unsuccessful Tools and Lessons Learned

The department did not adopt certain tools initially introduced to them for reasons that vary from lack of understanding, lack of knowledge, lack of data needed to complete or fully utilize a tool or it suggested to much change to the current culture and environment. Tools such as PERT, Trend Chart, Pareto Chart, FMEA and SIPOC were not only more complicated, but required quantitative data to complete. Unfortunately, the school district environment does not easily

supply quantitative data because of the type of environment and confidentiality laws to protect students. Without time stamps, student data, or rigorously defined processes these tools became very complicated and confusing to implement. Also, many of these tools simply overlapped some already existing practices and documentations. The cost benefit analysis, SOP, control plan, and 5S, for example, was not readily accepted based on the similarities to already integrated standards. Introducing and implementing new concepts, especially systems engineering concepts, to an audience who previously has not been exposed before was a challenge. This study highlighted best practices for achieving limited success that included: using visualization whenever possible, scale back on the number of concepts introduced, encourage tools to be used in a group setting, and show examples of why a concept is effective at the beginning to establish validity. Integration into the current system, culture and software packages are also vital and served as a crucial selling point.

Conclusions

The tools that were accepted and implemented improved the department's workload and processes, and Ford selected the school district as one of its communities. Based on my findings, the superintendent saw the need to restructure the department and add one additional personnel. I would not recommend attempting to implement a complete Lean Six Sigma project in this environment because of lack of data, lack of knowledge and cultural pushback. However, tools that were successfully accepted should be developed and implemented across multiple departments.

After having implemented a Lean Six-Sigma approach to different processes within a non-traditional environment, there is no debate that it has usefulness and will cause improvements. However, several roadblocks had to be navigated to make the process fit inside a school district environment. The largest deviation from a true project was the deletion of using any of the statistical tools and processes to identify problems and show results or improvements. Because of the nature of a non-manufacturing setting, there is not enough of a repeatable process that would give an analyst enough data points to conduct a statistical analysis on a problem and feel confident with his/her results. Also the principles do not work seamlessly within service industries, because of its different push and pull practices, how it treats "inventory" and its variety of demand. These statistical facts and processes are the backbone of a Lean Six-Sigma project, and are what drives the measurements and improvements. The best practices explained are all excellent tools that should be implemented in any organization. Improving upon any gaps and using the DMAIC system to tackle problems within an organization will, if implemented correctly, result in improvements. Using the tools and ideologies associated with this process should be highly encouraged. However, expect failure of a complete Lean Six-Sigma project inside of a service or school district environment based on the fact that the methodology was not designed for such an environment, and is not a well fit for the challenges it presents.

References

1. Arfmann, David & Federico, G. Topolanksy Barbe. (2014) The Value of Lean in the Service Sector: A Critique of Theory and Practice. *International Journal of Business and Social Science.* Vol. 5 No. 2
2. Gardner, Leslie. (2012). Is it Time for Six Sigma in Education? *ASQ Primary and Secondary Education Brief.*Vol. 5, No. 4.

3. Henderson, Jane. (2015) Six Sigma Yellow Belt. *Institute of Industrial and Systems Engineers.* www.iienet.org
4. Hicks, David. (2016) Leading and Sustaining Lean with 8 Step Problem Solving. *Auburn Technical Assistance Center.* www.auburnworks.org
5. Mazumder, Quamrul H. (2014). Applying Six Sigma in Higher Education Quality Improvement. *American Society for Engineering Education.* 121st ASEE Annual Conference and Exposition. Paper ID #8594.
6. Ruff, Mary. (2017). Using Six Sigma to Solve Issues in Public School System. iSixSigma.com. *https://www.isixsigma.com/implementation/case-studies/using-six-sigma-solve-issues-public-school-system/*
7. Walden, Clay & Golf, Les. (2016) Six Sigma Black Belt Certification. *Center for Advanced Vehicular Systems Extension*. Mississippi State University.
8. Wortman, Bill; Richardson, Wesley; Gee, Glenn; Williams, Mike; Pearson, Tom; Bensley,Frank; Patel, Jay; DeSimone, Joe; Carlson, DuWayne. (2014) The Certified Six Sigma Black Belt Primer. *Quality Council of Indiana*. Fourth Edition