Six Sigma Analysis of Productivity

Acme Meat Processing Plant

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# **Abstract**

This paper will apply the Six Sigma DMAIC process the production of single cuts of meat produced for a national grocery. The production facility has not produced the quantity or quality of cuts to the customer’s specs. The production facility has not made a profit wither and has been in business for one year. Using the DMAIC process, I intend to define, measure, analyses the processes failing and then improve and control the process.

*Keywords:* Six Sigma, DMAIC, control process, fishbone chart, production control chart

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# **Acme Meat packing Plant**

The Acme Meat Packing plant was opened to produce single cuts of meat to an individual customer with stores across the United States. The initial costs of the plant were partially subsidized from grants and a tax cut from the State of Tennessee and Davidson County, TN. The end costs were still substantial. The plant has been opened for 12 months and the goal to make a profit has not been realized. If no changes are made, the plant will close. The need for this project is to identify the root cause and change processes before it is too late.

# **Problem Statement**

Analyzing a production line for efficiencies can produce favorable results. A new production plant commissioned to produce single cuts of meat for a retail customer is not making a profit. Failing profit margins may cause the plant to close.

## **Current State Assessment**

The ACME meat packing plant was commissioned to produce several cuts of beef packaged for retail to be sold in Mickey’s Grocery stores nationwide. Managers for Mickey’s tour the plant daily to monitor progress and to make sure that the cuts are in line with company standards. The plant has been in production for one year and has yet to make a profit.

On each shift there are close to 450 workers in the facility. For this assessment, efficiency of the production line was evaluated. Staffing and training are issues which contribute to the shortfall on the production floor. The number of staffs in the facility at one time, all trying to share facilities is an additional and major contributor to poor production.

## **Quantifiable Factors**

ACME produces 15 products for Mickey’s Grocery’s. Each line varies to the amount of meat produced and the number of whole units within X number of seconds. For instance, each line should reduce one whole unit of meat every 6 seconds. Given time for blade changes, 7 hours of production for each shift should produce 58,800 units. So far, the plant has not consistently met that goal.

Most daily orders are not being produced within 7 hours of production therefore thousands of overtime hours are used to fulfil orders, for this reason profit is failing. If the production facility does not begin to fulfil orders and turn a profit it will close, and ACME will have lost millions of dollars for the build out of the new facility, employees will lose jobs, and ACME will take a hit to their reputation.

The scope statement outlines what the results of a project will be, the costs associated, the risks, assumptions, and constraints the project will endure. The scope statement is agreed upon by all parties involved in the project outcome (Portny). If changes occur, the scope statement will be revised.

# **Project Scope**

After measuring the existing processes, it was revealed that overtime and product waste were the reasons that the plant is not profitable. The benefitof this project will reduce waste, eliminate overtime, and create new processes that will cause and sustain profitability.

## **Project Schedule and Milestones**

A feasibility study revealed the need for the project. In December, the company owner, managers, and sponsors will start to create hype and draw employee engagement. The project is scheduled to begin January 2019, and end December 31, 2019. Black Belts in each department will meet with their team the last Friday of each month to celebrate wins, discuss progress and recommendations for further improvements. The first Monday of each month, Black Belts from each team will meet to report on each team’s progress. Each quarter, the Master Black Belt will also meet with stakeholders and management to reveal progress. The project must stay on time and on budget.

## **Milestone Chart**



Data during the project follow the RUMBA acronym. It will be measurable, and each milestone will mark progress on acceptable limits to waste and OT. By the first quarterly meeting these limits should be met and exceeded after this time.

## **Acceptable Criteria and Objectives**

Acceptable criteria for this project areprofitability. Limits will be established and must be exceeded at each milestone. The over-all project goal is the lower waste by 50% and eliminate OT all together. The limit at each milestone is a 10% improvement to each goal.

## **Deliverables**

The project deliverables include a full and well-trained staff. The staff will be trained to spot and eliminate waste. In addition, a new inventory tracking and ordering system will be purchased to better predict inventory needs and relay shortages or overages in real time to managers. Arrangements will be made with IBP for an improved response time when emergency supplies are needed, and a local supplier will be commissioned as needed. Lastly employees will work a new schedule based on their position. Data from the initial audits and there-after will be submitted with the close-out documents.

## **High Level Requirements**

The gap analysis revealed that there is a shortage of employees in several departments. Additionally, there are training opportunities as well. This project will ensure that we increase man power and train as needed to improve waste and eliminate OT and new software will be designed to deliver data to managers in real time.

## **Project Boundaries**

This project is designed to reduce waste and eliminate OT. Departments outside of this project include maintenance, security, and administration. Issues with outside services such as utilities, catering, laundry, etc. will not be included in this project.

## **Risk Assessment**

Risks associated with this project include department manager and employee buy-in. Managers must be on board 100% to allow their employees to participate 100%, we cannot afford any blockers. There is also the risk of staffing needs and departments being so understaffed that they cannot fully participate. If staffing causes an issue the project will go longer than expected, costing more money.

## **Constraints**

Constraints for this project include human resources. The unemployment rate in Davidson County, TN is 2.75 so it will be challenging to hire and retain good employees.

## **Assumptions**

The unemployment rate is very low in Davidson County, TN and other companies hire workers at a higher rate. Acme Meats is already in the hole and cannot possible offer a high starting wage. Additionally, a new schedule may interrupt existing employees live to the point they quit, this will create more of a challenge to hire the number necessary. Those remaining will need to be trained to identify waste and/or use different software or equipment, so a learning curve is expected.

## **Cost Estimates**

Costs associated to this project is estimated at $1,550,000.00 for project labor, $300,000 to purchase new software, $14,400 to train on new software, and $7,500,000 to hire and train an additional 300 staff member, for a total of $9,364,400.00

## **Cost Benefit Analysis**

Last year, the company paid out $6,822,569.00 in overtime hours, and it was estimated that there was an additional $7,945,269.00 in unnecessary waste. The company has never made a profit due to this waste. The cost of this project, if successful will outweigh the benefits and should result in a profit of $5,000,000.00 for the first year and then an estimated $15,000,000.00 thereafter.

## **Deadline**

The deadline for this project is December 31, 2019 with a budget of $9,364,400

# **SIPOC**

The SIPOC (Suppliers, Inputs, Process, Outputs, and Customers) diagram is helpful to define processes and to recognize which resources should and should not be included in the project. For the sake of this project, I have outlined two SIPOC’s found in Appendix A and Appendix B. The first being company wide, the second only acknowledges the suppliers, departments, and customers affected by this project (Simon).

# **Repeatability and Reproducibility**

Anything that can be counted can and should be controlled to increase profit. Most companies measure processes frequently as an ongoing improvement strategy. Six Sigma processes help a company to minimize losses through measuring processes while adding the human element of variability (Ohota & Jordache).

The Six Sigma repeatability and reproducibility (R&R) measurement tool, considers the process and the system used to measure the process. The purpose of conduction the R&R study is to ensure that the correct tool is used to gage the study and to identify opportunities due to human variables during the process.

Repeatability is realized when a master operator can achieve the same results, or an acceptable variance of the same results, using the same tool at various operations (Chieh).

Reproducibility refers to the results achieved by a different operator realizing the same results, using the same tool and gage of measurement as the master operator (Chieh).

It is important to first outline what is to be measured, once identified, the process can be analyzed and individuals for their effectiveness. The R&R tool will identify those who need further training.

## **Data**

The test will conclude the acceptable number of units processed during 30 days of production. The data used in this study are the number of units processed during each 7.5-hour shift. The data will come from 2 shifts and seven production lines. Variables to cause downtime will be noted but not excluded in the time series.

## **Data Collection**

To begin this test, a standard must be set. One qualified Six Sigma operator (Master Operator) will conduct a test on each line and on each shift to gage a lower and an upper standard limit. From this, an average limit will be set with an acceptable ratio. After this time, computerized production data results will be analyzed for 30 days. The Master Operator will run an R&R study to see if the operators combined will prove overall repeatability.

## **Accuracy**

The data itself will come from a computerized system which will track the number of units processed. This measurement has been accurate to date.

# **Statistical Process Control**

Statistical Process Control (SPC) is a method to measure quality during a process. Control charts are a good way to ensure that a process is in control before analyzing the data for quality. Additionally, a control chart can be used to recognize variations in the process and identify variables that could cause the influx (Berardinelli).

When in control, a process will vary within an upper and lower limit specified based on past data. A chart will provide three main elements to visually confirmation if a process is stable. In an ideal state, processes will be stable or on target 100 percent of the time. The three elements to a control chart are the control limits: upper, lower, and the central line or sweet spot.

A Six Sigma Black Belt worked diligently to gather data for this production facility. His assessment was used to set a production goal. The sweet spot being 8404 units per day per line, with an upper and lower limit of 8820 and 7980 respectively.

Data collected below are variable data taken over thirty days. It is measured by line and by hour. The control charts below present real time data, not data taken during the Master Black Belt assessment. As noted earlier, these charts can also identify points where other variables may interfere with a process.

Keeping in mind that the sweet spot is 8,404 units per day, this one-way Anova of production for lines one through seven demonstrates that there are issues on lines one through four that are not evident on lines five through seven.



The F-value here tells us that the variation between the lines are more than with the lines and therefore we should look at variables effecting those lines that do not come into play with the others.

Factor Information

|  |  |  |
| --- | --- | --- |
| Factor | Levels | Values |
| Factor | 7 | Day Line 1, Day Line 2, Day Line 3, Day Line 4, Day Line 5, Day Line 6, Day Line 7 |

Analysis of Variance

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
| Factor | 6 | 16268506 | 2711418 | 47.08 | 0.000 |
| Error | 203 | 11690088 | 57587 |  |  |
| Total | 209 | 27958595 |  |  |  |

Model Summary

|  |  |  |  |
| --- | --- | --- | --- |
| S | R-sq | R-sq(adj) | R-sq(pred) |
| 239.972 | 58.19% | 56.95% | 55.25% |

Means

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Factor | N | Mean | StDev | 95% CI |
| Day Line 1 | 30 | 7605.9 | 233.7 | (7519.5, 7692.3) |
| Day Line 2 | 30 | 7774.9 | 238.9 | (7688.6, 7861.3) |
| Day Line 3 | 30 | 7521.4 | 231.1 | (7435.0, 7607.8) |
| Day Line 4 | 30 | 7436.9 | 228.5 | (7350.5, 7523.3) |
| Day Line 5 | 30 | 7944.0 | 244.1 | (7857.6, 8030.3) |
| Day Line 6 | 30 | 8028.5 | 246.7 | (7942.1, 8114.9) |
| Day Line 7 | 30 | 8270.8 | 255.7 | (8184.4, 8357.2) |

*Pooled StDev = 239.972*

Looking closer at the data, using an X-bar R chart, and the time series plot we see that there was an issue on day five which lasted four days. Looking at the notes for that time-period it was discovered that a snow storm prevented product from reaching the production facility.





**Variable Effecting Production Per Hour**

Day -by-day, hour-by-hour, variables change in the production facility. Product availability, staffing, training, and breaks effect production. The process control seems to be very much in control in this aspect

. 

Much like production per line, the F-value here tells us that the variation between the lines are more than with the lines and therefore we should look at variables effecting those lines that do not come into play with the others.

Factor Information

|  |  |  |
| --- | --- | --- |
| Factor | Levels | Values |
| Factor | 14 | Hour 1, Hour 2, Hour 3, Hour 4, Hour 5, Hour 6, Hour 7, Hour 8, Hour 9, Hour 10, Hour 11, Hour 12, Hour 13, Hour 14 |

Analysis of Variance

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Source | DF | Adj SS | Adj MS | F-Value | P-Value |
| Factor | 13 | 92767143 | 7135934 | 490.22 | 0.000 |
| Error | 406 | 5910011 | 14557 |  |  |
| Total | 419 | 98677154 |  |  |  |

Model Summary

|  |  |  |  |
| --- | --- | --- | --- |
| S | R-sq | R-sq(adj) | R-sq(pred) |
| 120.651 | 94.01% | 93.82% | 93.59% |

Means

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Factor | N | Mean | StDev | 95% CI |
| Hour 1 | 30 | 3314.7 | 101.8 | (3271.4, 3358.0) |
| Hour 2 | 30 | 3899.5 | 119.8 | (3856.2, 3942.8) |
| Hour 3 | 30 | 3704.6 | 113.8 | (3661.3, 3747.9) |
| Hour 4 | 30 | 2983.2 | 91.7 | (2939.8, 3026.5) |
| Hour 5 | 30 | 3704.6 | 113.8 | (3661.3, 3747.9) |
| Hour 6 | 30 | 4289.5 | 131.8 | (4246.2, 4332.8) |
| Hour 7 | 30 | 4406.5 | 135.4 | (4363.2, 4449.8) |
| Hour 8 | 30 | 3860.5 | 118.6 | (3817.2, 3903.9) |
| Hour 9 | 30 | 4932.9 | 151.6 | (4889.6, 4976.2) |
| Hour 10 | 30 | 4117.9 | 126.5 | (4074.6, 4161.2) |
| Hour 11 | 30 | 3590.3 | 110.3 | (3547.0, 3633.6) |
| Hour 12 | 30 | 3817.7 | 117.3 | (3774.4, 3861.0) |
| Hour 13 | 30 | 3667.5 | 112.7 | (3624.2, 3710.8) |
| Hour 14 | 30 | 4289.5 | 131.8 | (4246.2, 4332.8) |

*Pooled StDev = 120.651*

This X-Bar plot shows that the process is capable and stable.



This time series plot reveals that there are issues at hours one, four, eleven, and thirteen. It will be easy to identify variable effecting production during these hours.



# **Measure phase**

Objectives of the Six Sigma measure stage are to define the process to be measured, define the means to measure the process, establish a baseline measurement, and to evaluate the measurement system.

## **Process Definition**

Acme Meat Packing produces portion size cuts of meat in individual packages for Mickey’s Groceries nationwide. The plant has been operational for one year and has not made a profit. The Six Sigma methodology will be used to determine opportunities in the production of the product. The flow chart below defines the sequence of processes that can each be measured to calculate a rolled throughput yield (RTY). Using a flow chart quickly identifies the current state and reveals any gaps in the process to ensures that the proper sequences are included in the measurements.



## **Measurement**

To insure consistency, one black belt measured processes on each line and each shift. The timeline to establish a current state baselines was 30 days. The test included the number of units processed during 30 days of production. The data used in this study are the number of units processed during each 7.5-hour shift. The data came from 2 shifts and seven production lines. Variables to cause downtime will be noted but not excluded in the time series.

## **Baseline**

To establish a baseline, a Six Sigma black belt took measurements for three months on each line for each process. The baseline was determined at 58,800 units each day as this is the capability of the process. In the current state, only 45,000 units are processed. The DPMO is calculated as follows: There are four opportunities on the production line to impede the process. Out of a possible production of 58,800 units per day, the opportunity to produce less is 58,673.

Future state dictates an acceptable base line to be 55,860 units processed, the DPMO is 12,500. The Lower acceptable specification limit is 55,860 units, and the upper specification limit is 61,740. The target units’ processes is 58,880.

## **Accuracy**

The data itself will come from a computerized system which will track the number of units processed. This measurement has been accurate to date. The data retrieved for the thirty-day time frame is as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sample / Data | Sample / Data | Sample / Data | Sample / Data | Sample / Data |
| 1              55860  3              58880  3              57640  4              59999  5              61005  6              56000 | 7              57000  8              59880  9              58800  10           61740  11           60000  12           55900 | 13           55995  14           56005  15           56009  16           56800  17           58880  18           57890 | 19           59009  20           59000  21           61570  22           60078  23           60453  24           61000 | 25           61700  26           60320  27           59203  28           58934  29           60111  30           59263 |

The mean for the data is 58,831 with a standard deviation of 1904.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | N | N\* | Mean | SE Mean | StDev | Minimum | Q1 | Median | Q3 | Maximum |
| Sample | 30 | 1 | 15.53 | 1.60 | 8.75 | 1.00 | 7.75 | 15.50 | 23.25 | 30.00 |
| Data | 30 | 0 | 58831 | 348 | 1904 | 55860 | 56950 | 59005 | 60163 | 61740 |

Using Minitab, the calculated Cp is .76 and the Cpk is .76. This tells us that the measurement process is accurate (Chart 1, Appendix B).

Next the yield was calculated and then the throughput yield. During the 30-day period 1,707,034 units were processed and 1,350,119 were processed between the upper and lower limit specified, therefore the overall yield was 79.1%. The throughput yield came in at 79.1% overall. The data are as follows:

* Process 1 = 52512 at 92.3% yield
* Process 2 = 48473 at 92.3% yield
* Process 3 = 47243 at 99.5% yield
* Process 4 = 45004 at 95.3%

The RTY was then calculated; 92.3 x 92.3 x 97.5 x 95.3 = 79.1%. Looking at each process yield, process 3 and 4 are in range, therefore further training and adjustment will be made processes 1 and 2.

# **Analyze** **Phase**

Root-cause-analysis is a process in which a team dives deep into a problem to get at its root cause. Most times visual diagrams are used during brainstorming operations (Figure 1, Appendix D). Stakeholders immediately involved are part of the team to identify the causes. Six Sigma operatives work with staff to train on new processes and then monitor them to ensure on-going compliance. Using analytical problem-solving techniques are a good way to look at prevention rather than solving a problem (Haviland, 2004).

The Acme Meat Packing plant had one huge problem to analyze; they were not making a profit. The plant manager tasked his Six Sigma Master Black Belt to form a team and get to the root of the problem. The first thing they did was create project personnel list (Appendix C). From there, they used a cause and effect diagram to look at each stage of the whole process of production. The team was comprised of plant managers and the owner and manager of Mickey’s. The USDA inspector had a small role to play as well. Once the owner of Mickey’s agreed to new specs that will not change, he no longer had an input into the project. The plant manager then handed the project over to his lead Master Six Sigma to manage.

The team gathered and began at a high level to define each process, and then analyze causes of issues within each that can be prevented. The root-cause analysis diagram revealed these high-level categories:

* Staffing
* Product
* Training
* Equipment
* Scheduling

The team then analyzed each category to identify causes contributing to a low production yield.

Staffing seemed to be an on-going issue at the plant. The reason for this is because of the cold weather environment in which the employees must work. The temperature on the production floor is 34-36 degrees. Therefore, there is great turnover so keeping a team on task and goal oriented is virtually unheard of.

Product availability was a concern as well. At times, there was an issue with ordering raw materials, having machinery available to deliver the product to the production floor, or having staff available to deliver it.

Training was the next issue identified. Those skilled to fix computerized machinery was hard to come by. Employees needed to be in-house trained, but management did not make allowances for this expense. Likewise, they did not set aside funding for a Six Sigma program. They hired a few Black Belts but stopped at that point. Training for production workers had its own set of issues, for instance, the managers kept changing specs for the final product. This caused issues on the lines because of language barriers.

The team identified issues associated with the plant equipment as well. The availability of it when needed was scarce and it seemed that other departments liked to “borrow” equipment leaving the raw material delivery drivers without the equipment needed to get the product to the production floor at the time it was needed. Additionally, there were times that machines parts were not ordered as needed, and this included saw blades.

Lastly, the team identified idle times on the production lines. This meant fewer units produced each day. They discussed changing the start, break and lunch times for employees on each line on each shift.

# **Improve and Control**

The last phase of the Six Sigma’s DMAIC is the control phase. This focuses on ensuring that the improvements are implemented. Prior to this the improve phase outlines the solution to the problem, costs and benefits to its implementation and any risks involved. To solve our problem, we identified five root causes which contributed to low production. These are staffing, product availability, employee training, equipment, and scheduling.

## **Staffing**

We identified staffing needs in raw product receivables, and on some production lines. There became a problem with getting the raw product to the lines on time due to a shortage of human resources. Additionally, some of the production lines were short staffed. It was recommended that we hire 347; 15 for raw product ordering and delivery specialists, 318 to fill positions on production lines, and 14 to replace seasoned operatives who will be promoted to trainers.

## **Product Availability**

At times, the inventory control specialists under-ordered product which lead to a deficit. It is recommended that we purchase out of the box inventory software to facilitate ordering. There are many great products out there, but we recommend FishBowl Inventory Manufacturing Software. Fishbowl offers an out of the box solution that is easily customizable. The manufacturing ERP includes inventory control, raw materials and asset management using barcoding, and can predict inventory needs (Fishbowl). The system can be fulling automated. The cost of FishBowl starts at $4,395 each user each year.

In addition to issues surrounding ordering product, staffing needs made it impossible to get the product to the product floor when needed. It is proposed that we add 15 raw product ordering and delivery specialists.

## **Employee Training**

There are training needs in several departments. Inventory control specialists will need to learn to use the new software.

Currently the plant lacks Six Sigma trained employees. It is recommended that one from each shift be Black Belt trained, and one on each line and each shift be Green Belt trained. Additionally, of the Green Belts, it is recommended that one from each language represented in the plant be trained.

It is recommended that employees are cross trained at each station and some cross trained at stations on various production lines. It is recommended that while in transition, one trained be stationed at each line on each shift. Once the process is in control and the plant begins making a profit, the number of trainers should be reduced.

Lastly, while the facility has a full staff to accommodate all types of maintenance, some lack training in computer failure of plant equipment. It is recommended that we bring in representatives from the equipment manufactures to train maintenance employees in the computerized equipment.

## **Equipment**

Aside from training needs, the new inventory control software can be used to order equipment and keep parts on hand such as saw blades, knives, protective equipment and clothing used on the production lines.

## **Scheduling**

Scheduling will go through the biggest change. It will need to be orchestrated and closely monitored. It is recommended that the plant change the schedule for production floor, equipment room, and raw product delivery employees. The new schedule should separate each line’s start time by 30 minutes. This will push other department employees back in time but will not need additional employees to accommodate a new schedule. The recommended schedule that must also be approved by the USDA plant inspector is:

Line 1 begin at 7am, line 2 at 7:30 and so on.

Shift 2 for line one will begin at 3pm, line 2 at 3:30pm and so on

By staggering the shifts, this will allow employees time to break and lunch and be back and ready to work on time. Currently we have only one cafeteria and it has been a strain to feed hundreds of employees at one time. Additionally, as the line shuts down for the break or lunch schedule, employees on each line will stagger their time away from the line so that when the stylists arrive back they have cuts of meat ready to tray.

## **Project Timeline**

This project is to begin January 2019. The major departments effected by changes for this improvement plan are the raw product inventory and delivery department, production, maintenance, and equipment ordering. Each department will begin improvement process January. High level meetings will occur in April, July October and then finally December. It is expected that the plant will begin to make a profit as early as June 2019.

## **Cost** **Estimates**

Costs associated to this project is estimated at $1,550,000.00 for project labor, $300,000 to purchase new software, and $7,500,000 to hire and train an additional 300+ staff members, for a total of $9,350,400.

Initially it was estimated that it would cost 314,000 to implement new inventory software. Fishbowl provides free initial and on-going training. The cost to activate 32 licenses for the software for one year only and the initial purchase is $300,000 with a yearly cost of $128,000 for licenses.



Acme can reduce costs in training by contacting the equipment manufacturer and having a representative train the maintenance staff on the computer portion of the equipment. It is recommended that at least 2 Six Sigma Black Belts and 14 Green Belts be trained and certified. In addition, 14 should be cross trained on each line and promoted to become trainers on each line. The total costs for training should not exceed $63,800.00.



Finally, staff will be hired in several departments to control inventory and production processes. The total hired should be 347, costing the company $7,436,200.00.



## **Risks**

The biggest risks associated with this project include staffing and department manager and employee buy-in.

Managers must be on board 100% to allow their employees to participate 100%, we cannot afford any blockers. If managers do not participate they must understand that they will be replaced. If the project runs longer or assumptions made cannot be implemented entirely, the plant will have to close, and this is unacceptable. Managers must be compliant from the start.

There is also the risk of staffing needs and departments being so understaffed that they cannot fully participate. If staffing causes an issue the project will go longer than expected, costing more money. The unemployment rate in Davidson County, TN is 2.75 so it will be challenging to hire and retain good employees who will work for a small wage. It may be possible to work with the US government to retain workers from South America on visa’s.

Other risks involved are product availability, weather conditions, trucker co-operation. These risks are not ongoing and should not affect the project in the long run.

# **Conclusion**

Using the Six Sigma process used to define, measure, analyze, improve upon and then control a process was extremely useful in this project. Once the team came together, using brainstorming ideas and an analysis diagram they were able to create control charts which allowed them to visually see where the process needs improving. Once identified and re-adjusted, the process is back in control and can easily be controlled from this point.

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# **Appendix A**

## **SIPOC Table 1 (Customer-Supplier Chain)**

Chain for: ACME Meat Packing Date: 10/18/2018

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Suppliers | Inputs | Processes | Product/Output | Customers |
| IBP  Sunshine Laundry  Industrial Equipment Inc.  Knives, Blades and Supplies  Mikes Cafeteria and Catering  Shell Oil  Ace Auto  ADC Tires  Dell  Boxes and More  International Trucks  Lee Company  Accounting Services  Personnel Services  PR Services  Nashville Electric  Piedmont Gas  Metro Water and Disposal  Security Services Inc. | Raw Meat  Coats, and aprons  Saws, grinders, metal tubs, and forklifts.  Knives, saw blades, skinners  Prepared foods, drink stations, microwave stations, vending equipment  Gasoline  Oil, filters  Tires  All computers throughout the plant  Meat trays, tray wrap, tray labels, boxes, box labels, box tape  Refrigerant Semi-Trucks  Refrigeration, electrical, and plumbing maintenance  Bookkeeping  Employees  Community relationships  Electric  Gas  Water and garbage disposal  Campus security | Hire employees  Train employees  Take orders  Order raw materials and supplies  Produce single cuts of meat to fill orders  Package meat Products  Label meat packages  Box meat packages  Ship boxes of packaged meat  Manage inventory of raw materials and end products  Manage finances  Manage relationships with community  Equipment ordering and maintenance  USDA plant inspections  Transportation and maintenance  Facilities management  Information management | Single packages of raw meat | Mickey’s Grocery Chain  Patrons of Mickey’s Grocery Chain nationwide |

**SIPOC Table 1**

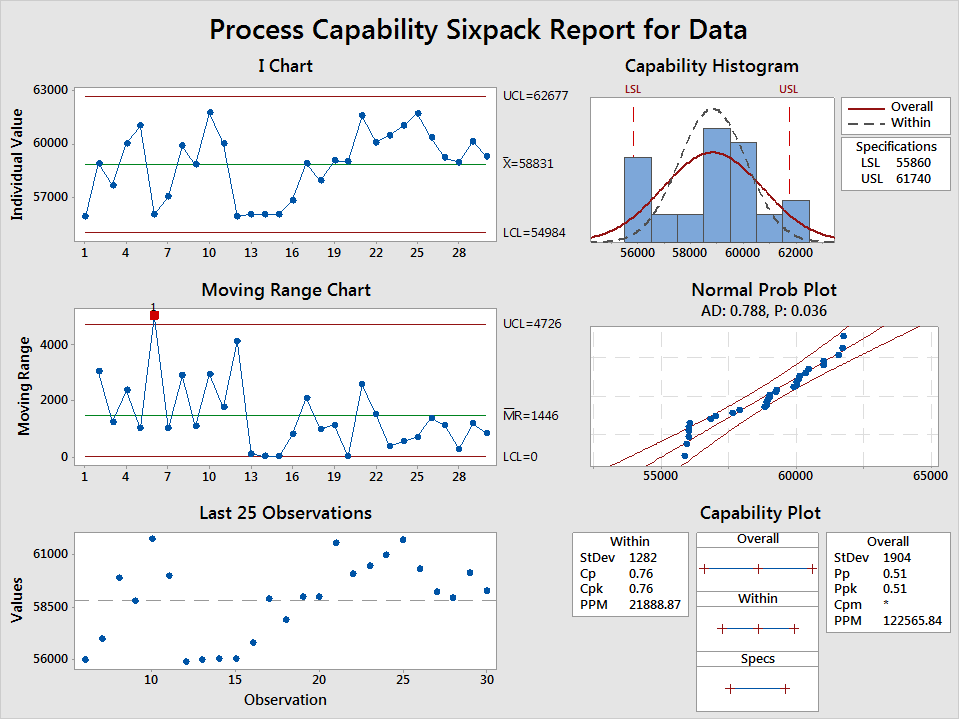
# **Appendix B**

## **Table 2** **SIPOC (Customer-Supplier Chain, revised for project)**

Chain for: ACME Meat Packing Date: 10/18/2018

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Suppliers | Inputs | Processes | Product/Output | Customers |
| IBP/Other Raw Meat Supplier  Procurement/Inventory Software Inc.  Personnel Services | Raw Meat  New Software  Employees | Hire employees  Train employees  Take orders  Order raw materials and supplies  Manage inventory of raw materials and end products  Deliver raw materials to the cut floor  Produce single cuts of meat to fill orders  Package meat Products  Label meat packages  Box meat packages  Ship boxes of packaged meat  Information management | Single packages of raw meat | Mickey’s Grocery Chain  Patrons of Mickey’s Grocery Chain nationwide |

## **Chart 1 Capability Report**



# **Appendix C**

## **Project Personnel List**



# **Appendix D**

## **Figure 1 – Root Cause Analysis Diagram**

