

BASELINE IMPLEMENTATION OF SIX SIGMA IN THE MANUFACTURING INDUSTRY OF THE PHILIPPINES

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Abstract

The study focuses on the baseline implementation of Six Sigma in the Select Manufacturing Industry of the Philippines using quasi-experimental approach. Of which found out that the following are the factors that contributed to the effectiveness of Six Sigma: Defect/error reduction, Customer satisfaction, Cost reduction and Better employee efficiency and found out that there are significant effects on the factors that contributed to the effectiveness of baseline implementation process using Six Sigma Methodology. Based on these factors, a project selection criterion for Six Sigma projects should be established of which the intensive support of the top management people is very essential in the establishment of total quality management eventually maximizing profitability.

Keywords: Baseline, Six Sigma, Effective Process, Manufacturing Industry, Quasi-Experimental

The concept of Six Sigma Process was pioneered at Motorola in the 1980's and the objective was to reduce the number of defects to a low as 3.4 parts per million opportunities. Many organizations have reported significant benefits as a result of Six Sigma project implementation.

Six Sigma has changed the manufacturing in every aspect of the industry, from the people and the machinery to the administration and the logistics. This aspect plays a vital role in improving the competitiveness of the modern business. But the most challenging question confronting business leaders nowadays, is not "How do we succeed"? "It is how do we stay successful and become more competitive"? and/or "What tools are we going to adopt to limit the reduction of errors in the production process of the industry"?

Many quality models and tools are being implemented by different manufacturing industries to improve the efficiency and profitability of the whole organization. Total Quality Management (TQM), is an approach to success through continuous improvement. Kaizen, refers to activities that continuously improve all functions and involve all employees from

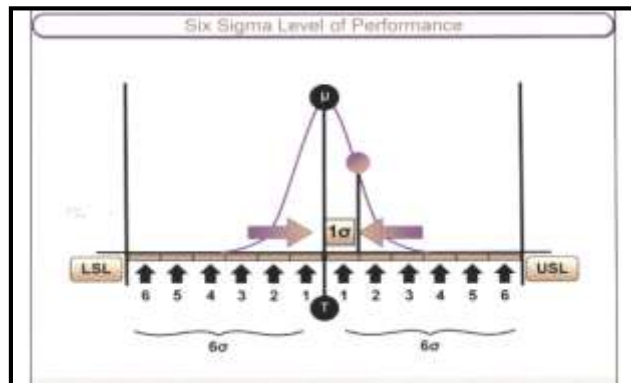
top to lower management. Benchmarking, is comparing one's business processes and performance metrics to industry's best and best practices from other companies. ISO certification, the International Organization for Standardization, promotes global standardization for specifications and requirements for materials, products and procedures. These are some of the programs and tools implemented by other manufacturing industries. However, research studies indicate that organizations implementing these frameworks have presented different results. Not all organizations implementing the concept of Six Sigma achieved dramatic results. Rather, many of them abandoned their initiative since it was not significantly contributing to the bottom line of the company. These contrasting results of Six Sigma implementation therefore, formulate the following defined questions: What are the factors that contribute to the successful implementation of Six Sigma? "Does adopting Six Sigma help at achieving better improvement in business performance?"

Review of Related Literature

The roots of Six Sigma as a measurement standard can be traced back to Carl Friedrich Gauss (1777-1855) who introduced the concept of the normal curve. The evolution of Six Sigma took a step ahead with Walter Shewhart (father of Statistical Quality Control) showing how three sigma deviations from the mean required a process correction. Later in 1980, Six Sigma got a definite form when a Motorola Engineer got the term Six Sigma for this quality management process. Motorola implemented the technique and copyrighted it as well (sixsigmaonline.org).

Bill Smith and Mikel Harry had written a research report on the new quality management system that emphasized the interdependence between a product's performance in the market and the adjustments required at the manufacturing point. The report indicated that the lesser the number of defects at each stage of production, the better is the outcome. This report was no less than a revolution because it paved the way for the implementation of the tool to solve the problems. Bob Galvin, the CEO of Motorola then, became the leader of the system, and with his analysis, the five logical stage became the skeleton of the present day Six Sigma. The five stages are also known as Define, Measure, Analyze, Improve and Control (Juran, 2004).

What is Six Sigma? Sigma is a measure of standard deviation, denoted by the Greek letter σ . The standard deviation of the output of a process tells you how much variation the product has. A process with normally distributed variation (or bell shaped curve) is symmetrical and has most (99.7%) of its outcomes within three (3) standard deviation on each side of the mean (center). The performance of a process with respect to meeting specification limits can be measured in terms of "sigma level", see Figure 1 (Juran, 2004).



Source: Juran Institute, Inc. Figure 1 Six Sigma Level of Performance

Sigma Level is the distance between the mean and the nearest specification limit; measured in terms of the number of standard deviations. This distance in terms of the number of sigma determines the sigma level. A “six sigma” process is one that was designed such that specification limits are six (6) standard deviations (or sigma) away from

the mean when the process performs as designed. Such a process in actual operation typically results in 3.4 or fewer defective parts per million (or defects per million opportunities (DPMO)). Unfortunately, many processes are only performing at two (2) to three (3) sigma level (Juran, 2014).

Metric Performance		
Sigma	Yield	DPM (Defect per Million)
1σ	31.00%	690,000
2σ	69.20%	308,000
3σ	93.90%	66,800
4σ	99.40%	6,210
5σ	99.97%	230
6σ	100.00%	3.4

Figure 2 Metric Performance

Source: Juran Institute, Inc.

Six Sigma can be viewed as a metric, a mindset and methodology. The first logical and commonly heard definition for Six Sigma is that, it is a statistical expression. The lowercase Greek symbol σ (sigma) is the metric or fundamental statistical concept that denotes a population’s standard deviation and is a measure of variation or dispersion about a mean. In simple terms, Six Sigma is a metric representing a process that is performing virtually free of all defects (Juran, 2004). A second definition, Six Sigma is considered an organizational mindset that emphasizes customer focus and creative process improvement. Mikel J. Harry (1998) stated as follows:

“The philosophy of Six Sigma recognizes that there is a direct correlation between the number of product defects, wasted operating costs and the level of customer satisfaction” (Juran, 2004).

With this mindset, individuals are prepared to work in terms of order to achieve Six Sigma and its ultimate goal of reducing process variation to more than 3.4 defects per million opportunities (Juran, 2004).

The third definition, Six Sigma is viewed as a strategic improvement methodology termed DMAIC. DMAIC is an abbreviation of the five (5) systematic steps in the Six Sigma Methodology.

It creates breakthrough by eliminating chronic problem that is causing customer dissatisfaction, defects, cost of poor quality or other deficiency in performance (Juran, 2014).

Figure 3

Six Sigma Infrastructure



Source: Juran Institute, Inc.

The organizational infrastructure for Six Sigma program consists of a hierarchy of roles of management and employees depending on the different levels of expertise. These roles are classified as (Juran, 2004):

1. **Champion** - individuals who have high level of understanding of what Six Sigma is and are committed to its success, usually it accounts the responsibility of the Executive Vice President.
2. **Master Black Belts** - this is the highest level of technical leadership in Six Sigma program. They must be able to assist Black Belts in applying the method effectively.
3. **Black Belts** - front line leaders of Six Sigma, They are full time project leaders with all the same responsibilities as from Green Belts.
4. **Green Belts** - are employees trained in Six Sigma who spend a portion of their time completing projects, but maintain their regular work role and responsibilities.

5. **Yellow Belts** - typically has a basic knowledge of Six Sigma, but does not lead projects on their own. They participate as a core team member on a project (Juran, 2004).

Six Sigma Methodology

A methodology is an organized set of methods, techniques and tools, developed to guide the whole cycle of a process to achieve its objectives.

The main focus of Six Sigma is to reduce potential variability from processes and products by continuous improvement methodology, abbreviated as DMAIC. It is a disciplined and rigorous process to solve complex problems by “getting the facts” before solutions are carried out. It uses projects to solve the most critical problems (Juran, 2014).

Figure 4
DMAIC Methodology



Source: Juran Institute, Inc.

Define (D) is the first step of the Six Sigma Methodology where leaders are expected to select project, set initial goals and develop a project.

Measure (M) is the second step of the Six Sigma Methodology. It measures the process performance. It becomes the origin from which the team can gauge improvement. This will serve as a baseline against which any incremental improvement will be measured and give further objective evidence on how much improvement may be possible (Juran, 2004).

Analyze (A) Teams can identify several possible causes (X's) of variation or defects that are affecting the output (Y's) of the process. It will examine the data and process to determine root causes and opportunities for improvement (Juran, 2004).

Improve (I) You will select the best solution to the problem or best design features and complete a cost benefit analysis which incorporates the cost of implementing the solution to estimate the actual bottom line benefit of the improvement (Juran, 2004).

In **Control (C)** finance will determine the actual benefits, institutionalize the improvement and sustain gains (Juran, 2014).

Conceptual Framework

The illustrated research simulacrum (Figure 5) describes the relationship among the key variables of the study.

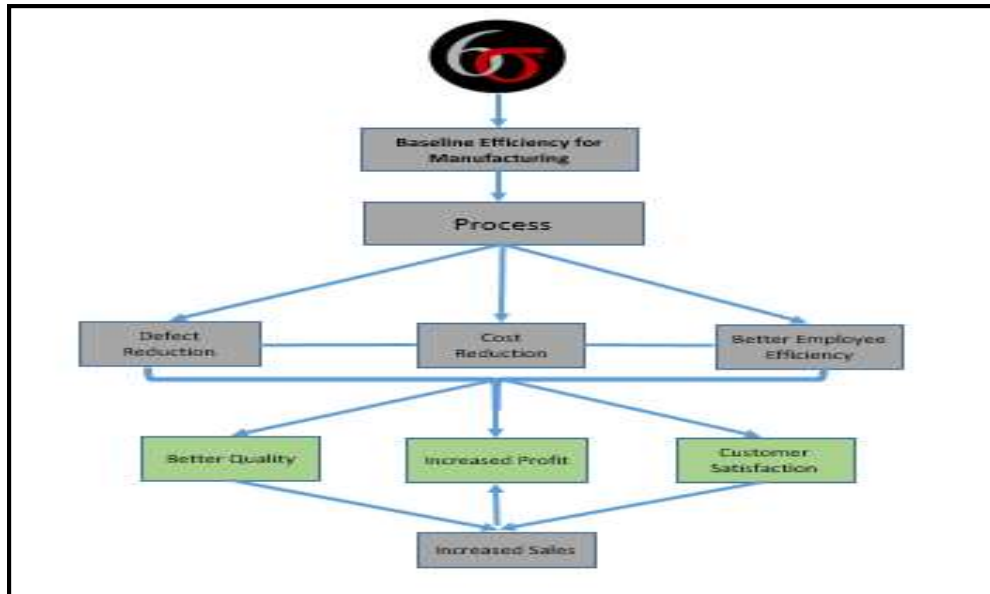


Figure 5

Research Simulacrum

Six Sigma plays a vital role in all aspects of every company. The factors that affect and contribute to the effectiveness of the implementation process. Hence, analyzing the root cause of the problem takes a lot of effort to determine the viability and solution to the problem.

Benefits can be experienced by the proper execution of every proposed project. Proper detection of defects/errors can save millions of pesos to a company and product improvement can lead to customer satisfaction and loyalty that can generate increase in the profit from the quality product that the company produces.

Statement of Objectives

The study specifically determines the following:

1. identify the key factors that contribute to the effectiveness of baseline implementation process using Six Sigma Methodology in the manufacturing industry
2. Measure the indicators as to:
 - 2.1. Defects/Error Reduction
 - 2.2. Customer Satisfaction
 - 2.3. Cost Reduction
 - 2.4. Better Employee Efficiency
3. Evaluate if there a significant change of baseline efficiency before and after the implementation process using the Six Sigma Methodology.

Methods

Research Design

The research strategy employed in this research project is Quasi- Experimental Approach. The emphasis of this study is on collecting and analyzing numerical data previously and the application of the concept.

The primary sources of the research data were collected using the questionnaire tool and interview from respective representatives of the Industry from the manufacturing industries in Clark Special Economic Zone (CSEZ), Clark, Pampanga. Data gathering was initiated from the Office of the Vice-President, Business Development and Enhancement Group through The Investment Promotion Specialists to request the list of manufacturing industries in Clark, Pampanga. which adopted the Six Sigma as a tool in the implementation process.

Articles by Joseph M. Juran from Juran Institute, Inc. and from the internet website on Six Sigma are part of the secondary data gathering.

Research Instrument

The researcher-made a questionnaire were utilized for the data collection applying the Scale Type questions were used to collect responses and rate the factors that contribute to the effectiveness of Six Sigma implementation process.

The instrument was first reconstructed and reviewed by a Process Engineer (Certified Green Belt practitioner) to check the design and selection of questions and adjustments were made based on the feedback from the Global Six Sigma Coordinator (GSSC). Both were in the same manufacturing industry.

Ethical Consideration

An informed consent was obtained to respect each of the respondent's willingness to participate on the study. It was clearly explained about the reason and purpose of the research, basically to determine the effectiveness of baseline implementation process using the Six Sigma Methodology in the manufacturing industry. To protect the identity and respect the privacy of each respondent, the researcher assigned a number coding to each participant on the answered questionnaires, and assured them that all of the information given will not be shown to anyone else aside from the researcher.

Data Gathering Procedures

A Permission Letter to conduct a study was forwarded to the representative of each manufacturing industry. Afterwards, the list was requested from the Office of Clark Developmental Corporation (CDC). All of the companies under the lists were visited and presented the questionnaires including others from Apalit and Mabalacat area. Responses from that of Laguna Techno Park were sent via e mail with the respective representative for the data collection purposes.

Statistical Analysis

Data gathered using the research instrument were summarized in tabular form, analyzed and measured statistically:

1. Simple descriptive statistical tool like weighted mean (\bar{x}) and standard deviation (stdev) was used describe the factors that contributed to the effectiveness of baseline implementation process using Six Sigma Methodology. Graph Chart was then reconstituted to elaborate the clarity of the presented data.
2. To describe the response category, a 5-point Likert scale was used as follows:

Scale	Range	Response Category
5	4.51-5.00	Very Highly Effective
4	3.51-4.50	Highly Effective
3	2.51-3.50	Effective
2	1.51-2.50	Somewhat Effective
1	1.00-1.50	Not Effective

3. **T-Test** was also used to measure the significant difference between the baseline efficiency before and after the implementation process.

Results and Discussions

Data Analysis

Part 1: presentation of the key factors that contribute to the effectiveness of baseline implementation and the corresponding indicators was obtained from the questionnaires and compiled using the data spreadsheets. This data will then have presented and analyzed using simple statistical tools. Each of the data was computed from its efficiency level (N=22) and computed the corresponding mean to determine its ranking. The analysis will be followed by discussions.

Part 2: as part of the validity and documentation of result, presentation of Six Sigma projects from the respondents will be highlighted to present the baseline efficiency before and after the implementation process of Six Sigma Methodology.

For Part 1: For tables 1 to 4, Ranked the factors that contribute to the effectiveness of Six Sigma implementation process based on the average ratings given by the respondents' personal experience and the corresponding verbal description.

Table 1 Defects/Error Reduction

Indicator	Mean	Verbal Description
1. Maintain fewer deficiency error	4.73	Very Highly Effective
2. Manage less product reworks	4.68	Very Highly Effective
3. Proper Identification on the typical causes of waste	4.00	Highly Effective
4. Understand causes of errors and eliminate the opportunity to create defect	3.82	Highly Effective
5. Optimize non standardized work and methods	4.00	Highly Effective
Grand Mean	4.25	Highly Effective

Legend: (5) 4.51-5.00 - Very Highly Effective (4) 3.51-4.50 - Highly Effective (3) 2.51-3.50 – Effective (2) 1.51-2.50 - Somewhat effective (1) 1.00-1.50 - Not Effective

From the data presentation, the following indicators got the same verbal description as being Very Highly Effective among the others, maintain fewer deficiency error (4.73) and manage less product reworks with mean of 4.68, followed by the indicators with the same mean of 4.00 and verbal description as Highly Effective, proper identification on the typical causes of waste (4.00) and optimize non-standardized work and methods. Last on the list is understand causes of errors and eliminate the opportunity to create defect with a mean of 3.82, with a grand mean of 4.25 as Highly Effective. Fewer deficiencies will avoid the costs of scrap, reworks and other waste, thereby lowering overall cost. Products with lower deficiencies or defects will be more beneficial to both the industry and the customer. From the proposed project of the respondents, illustrated the baseline efficiency before and after the implementation process. T-test was used to measure the significant difference between the baseline efficiency before and after the use of Six Sigma Methodology. It can therefore be concluded that the factors of Defects/Error Reduction can effectively contribute to the effectiveness of the Six Sigma Implementation Process.

Table 2 Customer Satisfaction

Indicator	Mean	Verbal Description
1. Retain Customer Loyalty	3.86	Highly Effective
2. Provide more desirable features that meet customer demand	3.73	Highly Effective
3. Delighted customer with superior quality and speed	4.00	Highly Effective
4. Having the right mix of product that are free from failures/defect	3.09	Effective
5. Products have the right features to meet the customer need	4.05	Highly Effective
Grand Mean	3.75	Highly Effective

Legend: (5) 4.51-5.00 - Very Highly Effective (4) 3.51-4.50 - Highly Effective (3) 2.51-3.50 – Effective (2) 1.51-2.50 - Somewhat effective (1) 1.00-1.50 - Not Effective
As shown from the tabular presentation, the top indicators from customer satisfaction are as follows: Products has the right features to meet the customer needs (mean 4.05) as the Highly Effective, next is delighted customer with superior quality and speed (mean 4.00) with a Highly Effective verbal description; retain customer loyalty (3.86) as Highly Effective and provide more desirable features that meet customer demands (3.73) Highly Effective and last on the list is having the right mix product that are free from failures/defect got an Effective rating with the same mean 3.09, with a grand mean of 3.75 as Highly Effective.

To meet customer requirements, the organization must address the dimension of quality by designing the right features and provide them without defects/error. It can therefore increase customer satisfaction and decrease their dissatisfaction. This not only elevates the salability of the products, but it also reduces the likelihood that customers will move to the competitors.

Table 3 Cost Reduction

Indicator	Mean	Verbal Description
1. Manage to allocate cost effective solution to define problem	3.91	Highly Effective
2. Proper execution of high value improvement projects	3.91	Highly Effective
3. Provide the resources necessary to get the problem solved	3.18	Effective
4. Optimize fewer deficiency that causes reworks and scrap	3.41	Effective
5. Formulate projects that improve the speed of processes to eliminate non-value added activities	3.27	Effective
Grand Mean	3.54	Highly Effective

Legend: (5) 4.51-5.00 - Very Highly Effective (4) 3.51-4.50 - Highly Effective (3) 2.51-3.50 – Effective (2) 1.51-2.50 - Somewhat effective (1) 1.00-1.50 - Not Effective

As shown from Table 3, from a verbal description of Highly Effective, got two (2) spots from the cost reduction factor with the same mean of 3.91; manage to allocate cost effective solution to define problem and proper execution of high value improvement projects. Next is, optimize fewer deficiency that causes reworks and scrap (3.41) as Effective description and formulate project that improve the speed of processes to eliminate non value added activities (3.27) Effective. Last on the list is provide the

resources necessary to get the problem solved with a mean of 18, as an Effective description, with a grand mean of 3.54 as Highly Effective.

Cost Reduction is one of the best factors to consider in determining the effectiveness of Six Sigma, because it is an ongoing, never-ending part of every business strategy. Aside from the profitability level of the industry, it will then be able to establish a good standing in the market and capture majority of the market share.

Table 4 Better Employee Efficiency

Indicator	Mean	Verbal Description
1. Promote involvement creativity and non-value added activities	3.27	Effective
2. Recognizes people wants to do Quality work	3.50	Effective
3. Provides time and support resources	3.09	Effective
4. Strives for continual improvement	3.45	Effective
5. Eliminates repetitive task	3.00	Effective
Grand Mean	3.26	Effective

Legend: (5) 4.51-5.00 - Very Highly Effective (4) 3.51-4.50 - Highly Effective (3) 2.51-3.50 – Effective (2) 1.51-2.50 - Somewhat effective (1) 1.00-1.50 - Not Effective

Last part of the presentation is the data on the last factor, better employee efficiency with a grand mean of 3.26 as Effective. Top spot is: recognize people wants to do quality work (3.50), second rank is Effective: Strives for continual improvement (3.45), followed by promote involvement creativity and non-value added activities (3.27) and the two last indicators are: provides time and support resources (3.09) and eliminates repetitive task (3.00) both has the same verbal description as Effective.

Employees are considered to be an asset of an organization and the level of the employee’s productivity in any organization is largely responsible for the profit making ability and its survival in the long run.

Part 2: served as the most elicit variables to prove the baseline efficiency of Six Sigma Methodology. Presentation of Six Sigma Projects from respondents will determine the baseline efficiency and measure using paired t-test to identify the significant difference of the key variables before and after the implementation process.

Table 5 Defect/Error Reduction Paired Sample Statistics

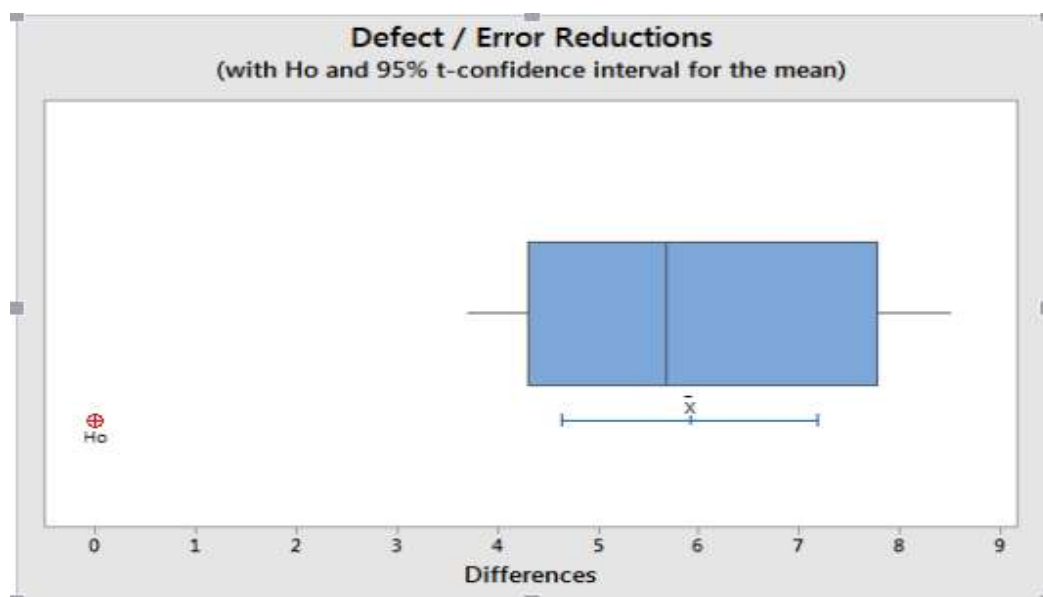
Paired T-Test and CI: Before, After

Paired T for Before - After

	N	Mean	StDev	SE Mean
Before	10	8.902	1.806	0.571
After	10	2.987	0.677	0.214
Difference	10	5.915	1.781	0.563

95% CI for mean difference: (4.641, 7.189)
 T-Test of mean difference = 0 (vs ≠ 0): T-Value = 10.50 P-Value = 0.000

Table 6 Defect/Error Reduction Box Plot Presentation



The presented data were drawn from a Six Sigma project that determined the defect per day and illustrated the actual monitoring defect rate on a daily (N=10) basis before and after the project execution. The result of the study, generated mean (8.902) before the implementation and mean (2.987) after the implementation of Six Sigma Methodology. T-test of Mean difference=0, T-value=10.50, proved that there is a tremendous improvement in the production process based on the monitoring project execution of a Six Sigma project. It revealed a P-value=0.000<0.05 level of significance, thus the null hypothesis (Ho), there is no significant change of baseline efficiency before and after the implementation process in terms of defect/error reduction was rejected.

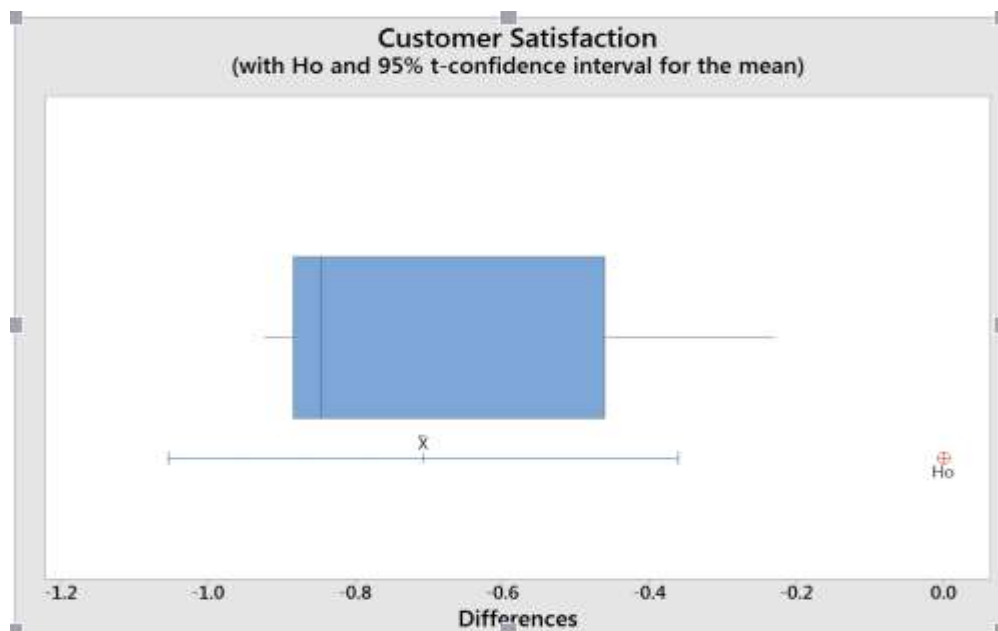
Statistical Conclusion: $P\text{-value}=0.000 < 0.05$, then reject the Null Hypothesis (H_0).

Practical Conclusion: There is a significant change on the baseline efficiency before and after the implementation process using Six Sigma Methodology in terms of defect/error reduction.

Table 7 Customer Satisfaction Paired Sample Statistics

Paired T-Test and CI: Before, After				
Paired T for Before - After				
	N	Mean	StDev	SE Mean
Before	5	3.1692	0.1668	0.0746
After	5	3.8769	0.1167	0.0522
Difference	5	-0.708	0.279	0.125
95% CI for mean difference: (-1.055, -0.361)				
T-Test of mean difference = 0 (vs ≠ 0): T-Value = -5.66 P-Value = 0.005				

Table 8 Customer Satisfaction Box Plot Presentation



From the project presented, Customer Satisfaction was highlighted because of its positive result towards the customers. Scorecard was the basis for the data gathering and N-5, as the number of customer representation. The results: Before Mean (3.1692)

and After Mean (3.8769), T-value=-5.66. It determine that the implementation of Six Sigma projects constituted positive result on customer satisfaction. P-value=0.005<0.05 level of significance, thus null hypothesis (Ho), there is no significant change on the baseline efficiency before and after the implementation process in terms of customer satisfaction was therefore, rejected.

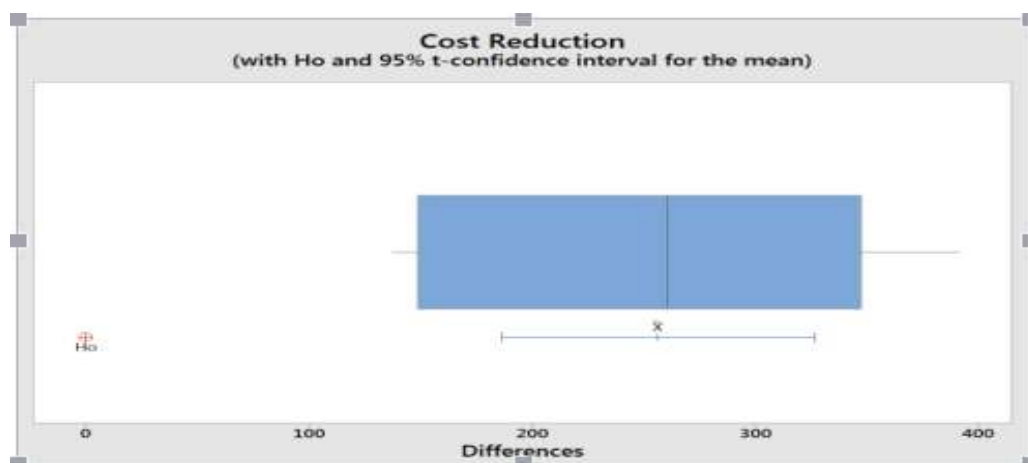
Statistical Conclusion: P-value=0.005<0.05, then reject the Null Hypothesis (Ho).

Practical Conclusion: There is a significant change on the baseline efficiency before and after the implementation process using Six Sigma Methodology in terms of Customer Satisfaction.

Table 9 Cost Reduction Paired Sample Statistics

Paired T-Test and CI: Before, After				
Paired T for Before - After				
	N	Mean	StDev	SE Mean
Before	10	318.8	101.2	32.0
After	10	62.3	20.5	6.5
Difference	10	256.4	98.0	31.0
95% CI for mean difference: (186.3, 326.6)				
T-Test of mean difference = 0 (vs ≠ 0): T-Value = 8.27 P-Value = 0.000				

Table 10 Cost Reduction Box plot Presentation



Paired t-test of baseline efficiency before and after implementation process in terms of cost reduction was identified in a Six Sigma project presentation. The number of rejected products was identified from before and after the implementation process. The data from after the implementation were decreased, therefore constituted cost reduction on the part of the industry. The mean before was (318.8) and the mean after

was (62.3). The proper implementation of Six Sigma project from this category identified the result after the implementation. A reduced in rejected products can lead to cost reduction. There was a T-value 8.27 and P-value $0.000 < 0.05$ level of significance, thus the null hypothesis, there is no significant change on the baseline efficiency before and after implementation process of Six Sigma in terms of cost reduction and was therefore, rejected.

Statistical Conclusion: $P\text{-value} = 0.000 < 0.05$, then reject the Null Hypothesis (H_0).

Practical Conclusion: There is a significant change on the baseline efficiency before and after the implementation process using Six Sigma Methodology in terms of cost reduction.

Table 11 Employee Efficiency Paired Sample Statistics

Paired T-Test and CI: Before, After

Paired T for Before - After

	N	Mean	StDev	SE Mean
Before	10	37.417	1.752	0.554
After	10	41.742	0.634	0.200
Difference	10	-4.325	1.901	0.601

95% CI for mean difference: (-5.685, -2.965)
 T-Test of mean difference = 0 (vs \neq 0): T-Value = -7.20 P-Value = 0.000

Table 12 Employee Efficiency Box plot Presentation



The last part of the presentation was the data from the key factors, better employee efficiency. The results: Before Mean (37.417) and After Mean (41.742) and t-value - 7.20, respectively. An identified Six Sigma project was illustrated to determine the

productivity rate of employee. The implementation of Six Sigma project was monitored (n=10) and the productivity rate identified. The P-value was $0.000 < 0.05$ level of significance, thus, the null hypothesis (H_0), there is no significant change on the baseline efficiency before and after the implementation process in terms of employee efficiency, was therefore rejected.

Statistical Conclusion: The P-value= $0.000 < 0.05$, then reject the Null Hypothesis (H_0).

Practical Conclusion: There is a significant change on the baseline efficiency before and after the implementation process using Six Sigma Methodology in terms of Employee Efficiency.

As a clear result, Six Sigma contributed to the improvement of product and service performance, improved financial performance and profitability of business, responsive to and focused on the customer demand and able to quantify quality programs based on the formulated factors such as defect/error reduction, customer satisfaction, cost reduction and better employee efficiency.

Defect/error reduction – opportunities are the things that must go right in order to satisfy the customer. Any undesired result would be considered a defect. The project should be selected where one can clearly measure the rate of defects as a function of opportunities. Based on the statistical conclusion, defect/error reduction has a significant effect on the effectiveness of Six Sigma Methodology. Therefore, the null hypothesis was rejected.

Customer satisfaction – This is another factor that contributed to the effectiveness of Six Sigma. Successful projects are tied to improving a primary metric that links directly to the customer. Based on the Statistical Conclusion, the customer satisfaction has a significant effect on the effectiveness of Six Sigma Methodology. Therefore, null hypothesis was rejected.

Cost reduction – by reducing the overall cost, we can always impact the bottom line cost and productivity and that leads to stable financial status and profitability of the business. Based on the statistical conclusion, the cost reduction has a significant effect on the effectiveness of Six Sigma Methodology. Therefore, the null hypothesis was rejected.

Better Employee Efficiency - Employees are considered to be an asset of an organization and the level of the employee's productivity in any organization is largely responsible for the profit making ability and its survival in the long run. Based on the statistical conclusion, better employee efficiency has a significant effect on the effectiveness of Six Sigma Methodology. Therefore, the null hypothesis was rejected.

Conclusions

From the aforementioned findings, the following conclusions were drawn:

1. Six Sigma is an effective tool to manufacturing industries, based on the proposed project and analysis given by the respondents. Top management commitment and

support for Six Sigma program is vital and crucial. Top executives must be part of Six Sigma and should contribute towards its implementation through visible commitment and support, resource provision and communication.

2. The following are the factors that contributed to the effectiveness of Six Sigma: Defect/error reduction, Customer satisfaction, Cost reduction and Better employee efficiency. Based on these factors, a project selection criterion for Six Sigma projects should be established. Each proposed Six Sigma project should be properly evaluated to create maximum impact on the customer satisfaction and ultimately the bottom line of the company.

3. All of the factors enumerated, have significant effects on the factors that contributed to the effectiveness of baseline implementation process using Six Sigma Methodology.

For Future Use

In the light of the research findings and conclusions, the following recommendations are being offered as follows:

1. Defect/Error Reduction

The effective use of DMAIC Methodology is the key factor to eliminate the defect in every manufacturing process. Proper identification of the problem is the starting point to achieve breakthrough improvements. Once a process improvement project is defined, the certified practitioner will systematically measure, analyze, improve and control that process in their drive for error reduction. Fewer deficiencies will avoid the cost of scrap, rework and other wastes, thereby lowering the overall cost.

2. Customer Satisfaction

Organizational performance must improve the process speed and sustain performance to achieve breakthrough. From the customer's perspective, quality means that goods and services are fit for the purpose that the customer has in mind. For an organization to continue making breakthroughs and meet the needs of their customers, they must master the skills to plan, control and improve quality to meet customer requirements and gain customer loyalty.

3. Cost Reduction

Eliminate the costs of poor quality. The purpose of Six Sigma is to quantify the costs, find its causes and remove them. Proper project implementation are the means to mobilize the defined problem and eliminate the cost.

4. Better Employee Efficiency

Rewards and recognition. This is one of the most important motivator to every employee, the result will maximize employees' potential and involvement and become one the main contributors to the company's journey to quality output.

Continuous Training and Certification. It is an important factor to consider because the result will be more beneficial not only for the company but to the employees as well. In most cases, trainings are considerably expensive but the output from the training is more viable to company.

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