Solving Quality Issues in Automotive Component Manufacturing Environment by utilizing Six Sigma DMAIC Approach and Quality tools

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***Abstract*— In this paper the identification of the suitable effective tools based on DMAIC (define-measure-analyze-improve-control) model for automotive component manufacturing was investigated with respect to detailed determination of the five phases of DMAIC. Currently the implementation of the DMAIC in industries has numerous versions in the classification for every phase. One of the issues is the application of tools for each phase is different by practitioners and secondly, the verification of the phases is also not clearly defined. The detailed steps and processes of DMAIC usually depend on the experiences, knowledges and availability of the data collection. Thus, in this paper, detailed adaptation process for each phase in DMAIC is investigated through published literature, current implementation of DMAIC in case study industry and production reject rate in case study industry. Based on the investigation and implementation from the case study industry, the result shows adaptation of DMAIC with suitable tools for each phase complements well with the quality improvement program. The reject rate of the product as determined through the developed DMAIC tools is similar with the case study industry.**

Keywords*— *DMAIC, automotive component industry, five phases, description, quality improvement program.

I. INTRODUCTION

Quality is a term that carries important meaning to both producer and customer in market. In the global marketplace today, many organizations realized that its survival in the business world depends highly on producing high quality product and services. Indeed, a lot of organizations have emphasized that quality should have to be put in place, integrated within the management system, especially in terms of bringing the end products or services to the customers. Accordingly, Total Quality Management (TQM) has become increasingly prevalent as one of the management strategies in ensuring customer satisfaction and loyalty, improving products and service quality and reinforcing continuous improvement [1]. There are many roads to quality, each of which is represented by methodologies that attempt to encapsulate complex theories in simplified forms. The concept of zero defects is remarkable for its simplicity and directness. But a process without defect doesn't just happen. Performing task right the first time only works if it can be done right the next time.

Abidin et al. [2] had conducted the study about Design Capabilities Development for Malaysian Vendors in Automotive Industry and they found that the critical success factor for quality improvement such as proximity is important for accuracy of the data analysis and integration. TQM would be one of the measurements to ensure that the automotive components produced are satisfactory and reliable for the customers, and to ensure competitiveness in the market, as well as in accordance with to the international standard. The TQM concept by using six sigma will be adopted for this research, which uses a DMAIC model and addition with other quality tools such as 7QC tools and automotive core tools to complete the research. A DMAIC model is based on achieving zero defects where the whole quality process is an attitude towards a performance standard [3-7]. With a zero defect mind-set, each defect is rigorously traced to its root cause, and each cause is then will be prevented [8-13].

Currently the implementation of the DMAIC methodology in industries has numerous versions for example Project DMAIC (P DMAIC) [15-16], especially in the classification for every phase. One of the issues is the application of tools for each phase is different by practitioners and secondly, the verification of the phases has not also clearly defined. The detailed steps and processes of DMAIC usually depend on the experiences, knowledges and availability of the data collection. Thus, in this paper, detailed adaptation process for each phase in DMAIC is investigated through published literature, current implementation of DMAIC in case study industry and production reject rate in case study industry with regards to the current trend of the quality issues. The research presented in this paper had been conducted through problem solving activities of the product quality by identifying and adopting the effective suitable tools for the DMAIC stages.

II. THE CASE STUDY AND THE PROBLEM STATEMENT

The case study company supplies the car audio products to the reputable automotive manufacturers. The layout of the production shop floor consists of three different sections: part preparation, surface mounting process and final assembly. The process is sequential, in batch, multi-path and asynchronous. At the back end, there are several assembly cells, each accommodates different product families. The focus of the case study is final assembly of the production of XXX product where the reject rate is analyzed. The processes involved include Front-of-Line (FOL), End-of-Line (EOL) and Final Inspection. The reject rate has been monitored within twelve months in the Final Inspection process and the data has been analyzed, and the solution to reduce the part defects needs to be found.

The selection of the problem to be solved is based on Voice of Process (VOP) as highlighted by the Quality Control (QC) in final inspection process. The high reject rate has been recorded for XXX product. Based on this information, the ABC-XYZ analysis has been conducted and the table of summary of ABC-XYZ analysis is shown in Table I. The product families of the XXX are divided into three main products which are WWG, HC and PAN. Based on Table I, the product of WWG has been confirmed as a case study product because of its high volume from the XXX family and the defect parts of an average of 4,800 units per year.

TABLE I. SUMMARY OF ABC-XYZ ANALYSIS

Number of defect	Z2	4800	1500	200
% defect	Z	0.80%	1%	0.50%
% of volume	Y	75.95%	18.99%	5.06%
Volume per year	X	600000	150000	40000
		A	B	C
		WWG	HC	PAN

The relationship of the supplier, in-house production and customer has been studied by using SIPOC approach. This is to study the impacts of the problem into three parties. Product defects will effects the productivity of the production and indirectly will cause the part delinquent into customer. Increasing the capacity to fulfill the customer will cause the increasing the cost because of the planning of the over-time and the supplier in supply chain must provide extra raw material into company. The WWG product is required nine types of the raw materials to complete the assembly process, from nine different suppliers and the reject rate will effects the production planning for entire supply chain. Considering this factors, the problem must be solve to reduce the overall operation costs. The SIPOC summarize in Fig. 1 to illustrate the situation of the Supplier, Manufacturing and Customer relationship. the volume order from customer unable to meet by manufacturing due to reject rate 0.8%. The reject rate also will effects the production planning from various suppliers due to different cycle time.

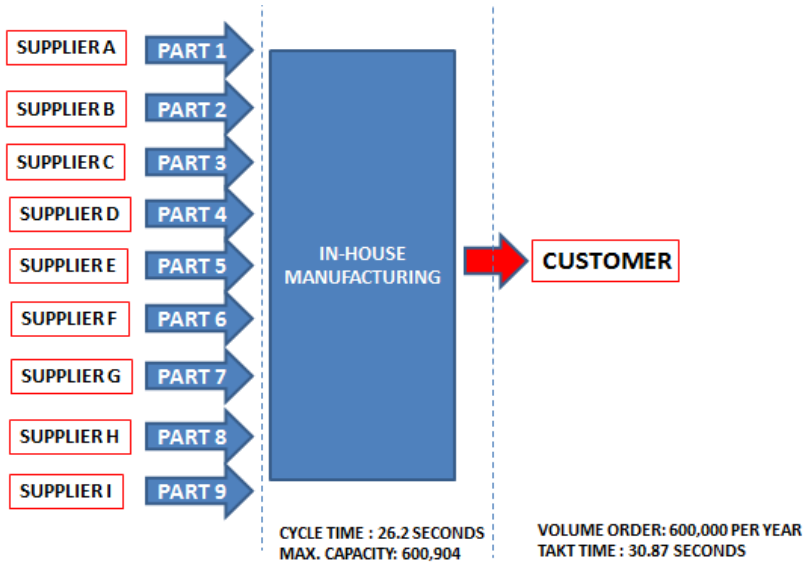

Fig. 1. SIPOC analysis

The investigation on solving the quality issue is divided into five phases which are Define-Measure-Analysis-Improve-Control. Define phase is defining the current quality issue in production processes and the expected outcome after completion of the improvement activity is derived. Measure phase is measuring the defect of the product through application of the selected quality tools to determine and visualize the current quality issue. Analyze phase consists of application of the quality tools to determine the possible causes of the defects and analyze all the possible causes to determine the main root causes. Improve phase is the stage of implementation as a counter measure to solve the quality issues, while Control phase is the phase of controlling the process and ensure the defects will not occur in future.

III. APPLICATION OF SIX SIGMA DMAIC WITH QUALITY TOOLS METHODOLY

This section presents and discusses the application of the Six Sigma DMAIC and quality tools for each phase through a real world case study implementation. In order to derive upon reliable and detailed Six Sigma DMAIC and quality tools approach, it is imperative to comprehensively determine the actual steps of the study itself.

A. Define Phase

Define phase consists of the four tools which are Voice of Customer (VOC) or Voice of Process (VOP), Cross functional team forming, 5W1H (Why, When, Who, Where, What and How), and scatter plot. This phase begins with solving the customer issues. The customer can be divided into two categories which are external customer and internal customer. External customer means those who are buying or paying the product, while the internal customer is the in-house processes, where the next process can be said as the customer for the previous process. VOC means the feedback from customer about the quality of the product, while, VOP means the process feedback about the previous process which is normally inspected by quality control (QC). Both feedbacks must be analyzed to ensure improvement activity will give high impact in terms of overall operation cost. Once the product to be study has been selected, the next step is cross-functional team forming, where the team members from various departments are formed to ensure all the reliable data or information will be collected. The brainstorming on the background of the problem begins with the hypotheses questions, usually by using 5W1H technique. This technique, in theory can generate the ideas how to solve the problem. This phase ends by applying the scatter plot to visualize the current situation of the reject rate. The plotting of the line chart will show the trend of the reject rate based on the observation time. From the scatter plot, setting the goals or objective of the improvement activity will then be initiated.

1. Team Forming and 5W1H Analysis

Once the product has been selected, the cross-functional team is formed to solve the problem and team members can be representative from Industrial Engineering, Process Engineering, Maintenance Engineering, Production, Quality Engineering and also Incoming Quality Control, as the representative from the Finance Department to endorse the financial impacts. Each member from various departments is selected from those who have the knowledge of the product and the improvement project begins with developing the project charter to define the problem statement, objective or goals, project planning and the impact by the end of the activity. Initial analysis of the problem is discussed through the hypothetical question and the initial idea how to solve the quality issue is generated by using 5W1H Analysis and this analysis is summarized in Fig. 2.

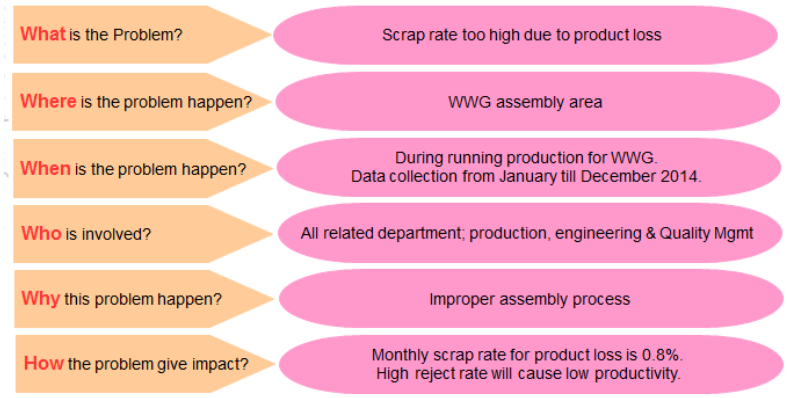

Fig. 2. 5W1H analysis

2. Scatter Plot

The defects of the WWG product involved all departments and cause the low productivity of the production process. Understanding the background of the quality issue will be better off if it is translated into visual management, which is by plotting the scatter plot to visualize the reject rate in percentage, as shown in the graph in Fig. 3. The result of the graph shows the average reject rate for twelve months monitoring data is 0.8% and the goal of this improvement activity is to improve the reject rate from 0.8% to 0.4% by the end of the improvement activity.

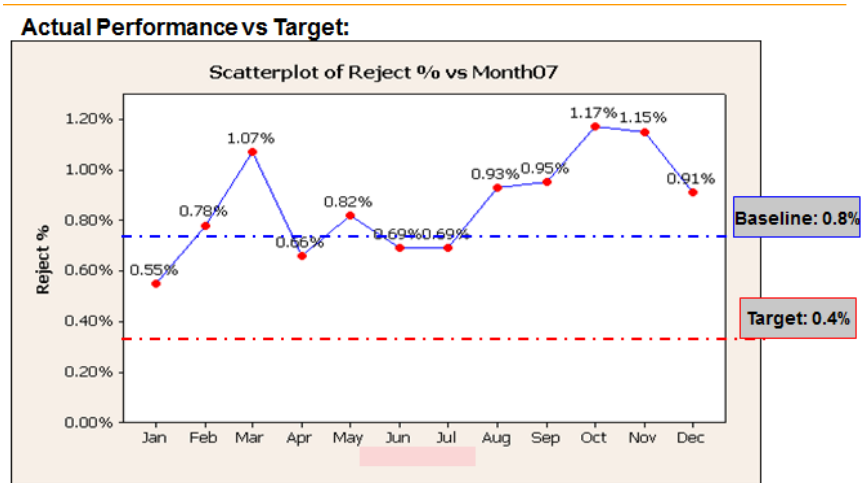

Fig. 3. Scatter plot of the reject rate

B. MeasurePhase

The Measure phase consists of applying the Pareto chart, process mapping and process capability. Several types of defects will be captured and identified during observing the data and focusing on the problem solution. Generally the Pareto chart is used to define and visualize the main contributing elements that contribute to the reject rate. Type of defect, defect quantity and cumulative percentages of defect quantity are usually used in plotting the Pareto diagram. Through the charting mechanism, it shows the weightage on how much effort need to be ratified which resulting in better use of limited resources by application of the 80/20 rules. Next, Process mapping is applied as a tool by using basic concept of the process flow chart to mapping the potential processes contributing to the partial failure. Once the potential processes area has been detected, the process capability study will be conducted to calculate the process capability (Cp) and process capability index (Cpk). The purpose of this analysis is to identify the stability and accuracy of the process. Based on the quality standard, the value of Cp and Cpk more than 1.0 representing the process is stable.

1. Pareto Chart

High numbers of reject rate due to various types of defects, and measuring type of defect are conducted in the Measure phase. This phase begins with plotting the Pareto diagram to identify the focus area and understand all types of defect contributing to the high numbers of reject rate. Based on the observed attributed data, the type of defects can be divided into

four main categories which are not function, shaft bent, hanging and others. From the information and the data collection, the Pareto chart is plotted to visualize the quantity and type of defects as shown in Fig. 4. From the Pareto chart, the scope of this improvement activity will be focused on the defect not function only, fulfilling the 80/20 rule.

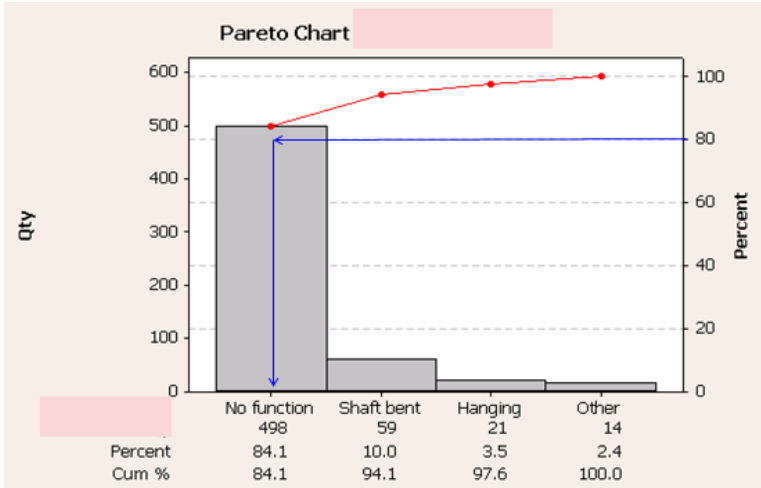

Fig. 4. Pareto chart

2. Process Mapping

Detailed investigation of the defect in which the part is not function is investigated through discussion and analysis of the sample defects part and the result shows that type of not function because of stuck pin of the component. Process mapping has been applied to map the causes of the stuck pin of the component, and to identify the potential processes where the defects part orginitated from. All the processes involved processes were screened to identify the potential process contributing to the defects. The investigation found the process of assembling the WWG product could be divided into two sections which are Front of Line (FOL) and End of Line (EOL) and both sections were investigated. The result of the process mapping is shown in Fig. 5 and there are three potential processes that have been found contributing to the defects part based on the discussion and analysis among the team members. The processes are winding process in FOL and bend pin process and solder component leg in EOL. The detail investigation was then conducted to define the root causes of the quality issue by studying the process capability analysis.

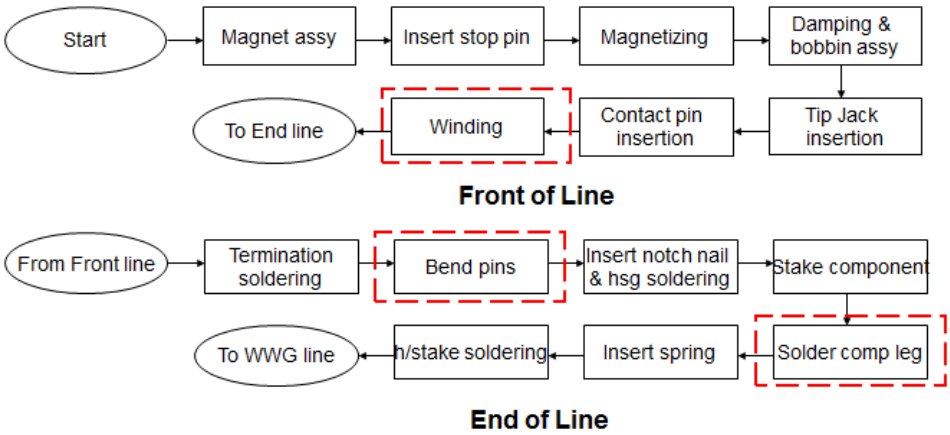

Fig. 5. Process mapping

3. Process Capability Study

The process capability study of those three processes which contributed to the defect has been conducted to verify whether these processess have major contribution to the defects part. Based on the possibility of the causes of the stuck pin identified from process mapping, the process of winding, bend pins, and solder component leg might possibly contributing into stuck pin. The analysis of the process capability is based on the type of the data which is divided into two categories either variable data or attribute data. The variable data is measurable data and attribute data is a unmeasuable data or count

data and the approach of analysis for both types of data is different. The process capability in term of calculation Cp and Cpk study was applied for the variable data and the calculation of the reject rate was applied for the attribute data. If the value of Cp and Cpk value less than 1.0 for the variable data and found the defect for the attribute data, means the process have a possibility contributing into defect part.

The first potential process is winding process is a wind the wire into a coil for the magnetic purpose and the critical issue is the thickness of the height of the wire winding. The specification of the winding wire is 7.1±0.15 mm. Upper than specification limit will cause the part to loose and lower than the specification limit will make the part to stuck. For the investigation purpose, the 20 samples of variable data have been collected in winding process by measuring the height of wire winding to study the process capability. The sample data of the height of winding is shown in Table II and the Cp and Cpk was calculated. The result of the capability study of the winding process shows, even the data is all within the specified limit but the process is not capable because Cp and Cpk <1.0. The improvement is needed to ensure the process is stable by achieving Cp and Cpk > 1.0 and at the same time reducing the number of part defects.

TABLE II. PROCESS CAPABILITY STUDY FROM SAMPLE DATA OF THE THICKNESS OF THE WINDING WIRE (IN MM)

7.11	7.11	7.25	7.20
7.15	7.21	7.20	7.22
7.18	7.15	7.18	7.20
7.11	7.20	7.11	7.25
7.10	7.11	7.21	7.25
Mean, μ			7.175
Standard deviation, σ			0.052
Cp			**0.96**
Cpk			**0.80**

The second potential process is the bending pins process which is the specification of the bending of the pins is 45□±5□. Over bending will cause the housing to stuck and under bending will cause the housing to loose. The 20 variable data of the process of bending pin have been collected in the bend pin process with the purpose to study the process capability. The sample data of the bending pins shows in Table II and the Cp and Cpk was calculated. Based on the result of the capability study of the pins bending process, the process capable because Cp and Cpk >1.0. This process might be not considered as a potential failure to process because of the result status is capable process.

TABLE III. PROCESS CAPABILITY STUDY FROM SAMPLE OF THE DEGREE OF PINS BENDING (IN □)

45	46	43	45
46	44	44	44
45	45	44	47
45	45	45	43
44	44	45	47
Mean, μ			44.8
Standard deviation, σ			1.105
Cp			**1.51**
Cpk			**1.45**

The third potential process contributing to the defects which is soldering process was investigated in solder component leg and attribute data has been collected because of the data is based on the status of the part either accept or reject. The visual inspection has been conducted in process of solder component leg with the purpose to collect the data of the reject rate of the soldering process. The 240 sample parts completion the soldering process has inspected to verify either that parts acceptable or not. Out of 240 samples, parts, 5 parts have been found defects or equivalent to 2% of reject rate. That means this process has a potential to be investigated because of contributing to the defects.

C. Analyze Phase

The third phase is Analyze, consists of brainstorming all possible root causes by using Ishikawa diagram and a selection of the possible root-causes through multi-voting to identify the possible root-causes of the potential causes as identified in Measure Phase. Since the Measure phase found the part not function due to stuck pin is the main defects, the brainstorming session was conducted to discuss the possible root causes of the defect and plotting into Ishikawa diagram according to the process capability study which is defined two potential processes; winding and solder component leg. Generally by using these tools the main root causes of the unrequired processes can be identified and then the processes can either be eliminated or minimized accordingly depending on the solution derived. The Ishikawa diagram is used as a guideline during a brainstorming session. The brainstorming session using Ishikawa diagram involves cross functional team members to ensure all possible root causes will be recorded based on the four factors which are man, method, material and machine. The Ishikawa diagram can also allow the possible causes or problem to be identified structurally and can also determine the relationships between potential causes of problems. Several numbers of possible root causes are identified during brainstorming session, and all the factors must be filtered out to choose the possible root causes which are really contributing to the defects. Upon completion of the brainstorming session, the team members must conduct another session, which is known as multi-voting session to select the potential root causes based on the rating score one to ten.

1. Ishikawa Diagram

The Ishikawa diagram is the brainstorming session among team members to brainstorm the possible root-causes of the defects of stuck pin. The failures of stuck pin cause for the most part not the function has been investigated the possible root-causes by using an Ishikawa diagram. The Ishikawa diagram for the stuck pin was shown in Fig. 6. Four common areas which are man, method, material and machine has been investigated for both of the potential failure processes as per defined in Measure phase which are Winding Process and Solder Component leg.

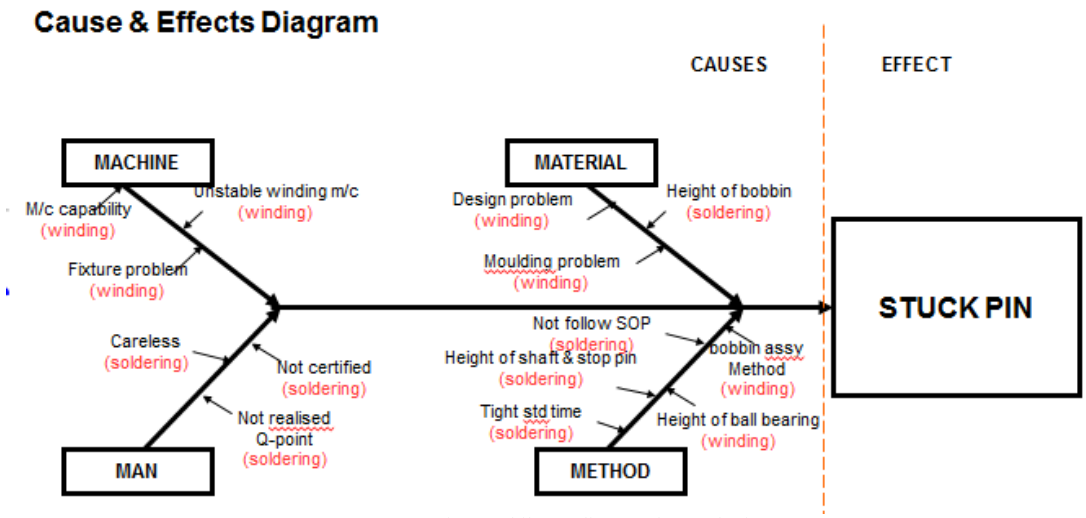

Fig. 6. Ishikawa diagram for stuck pin

2. Multi-voting Analysis

Since the possible root-causes has been brainstormed and the possible root causes were recorded, the multi-voting analysis has been adopted to select the root causes based on mutual agreement among team members. From the 14 possible root causes from the Ishikawa diagram for stuck pins, three potential root causes have been selected based on the highest number of ratings according voting from the team members and the listed potential root causes according to the ranking one to three, there result shows unstable winding machine, height of shaft and stop pin and bobbin assembly method is a processes contributing into the defects. The detail analysis of the multi-voting activity shows in Table IV.

TABLE IV. MULTI-VOTING ANALYSIS FOR STUCK PIN

MAIN	BRANCES	TEAM MEMBERS					TOTAL	PRIORITY
		HELMI	MALA	LEONG	NORDIN	IZWAN		
MAN	CARELESS	4	4	4	5	4	21	10
	NOT CERTIFIES	4	3	4	5	5	21	11
	NOT REALISED Q-POINT	5	3	3	3	2	16	12
METHOD	TIGHT STANDARD TIME	2	3	3	2	3	13	14
	HEIGHT OF SHAFT AND STOP PIN	7	6	7	7	7	34	2
	NOT FOLLOW SOP	4	4	5	4	5	22	9
	BOBBIN ASSEMBLY METHOD	6	5	7	8	6	32	3
	HEIGHT OF BALL BEARING	6	6	6	6	6	30	4
MATERIAL	HEIGHT OF BOBBIN	6	4	5	6	5	26	6
	DESIGN PROBLEM	4	3	3	3	2	15	13
	MOULD PROBLEM (INCOMING)	5	6	5	5	6	27	5
MACHINE	MACHINE CAPABILITY	5	4	5	6	4	24	8
	FIXTURE PROBLEM	5	4	5	6	5	25	7
	UNSTABLE WINDING MACHINE	7	7	7	7	7	35	1
	REMARKS:							
	RATING SCALE	1	5	10				
		LESS	MODERATE	HIGH				

D. Improve Phase

Once the project teams are satisfied with their data and determined that additional analysis will not add to their understanding of the problem, it's time to move on to solution development and known as an Improve phase. The team is most likely collecting improvement ideas throughout the overall activities, but a structure improvement effort can lead to innovative and elegant solutions. In order to ensure the right decision is made, the potential countermeasures will be identified through the observation and discussion, the hypothesis test should be conducted to ensure the counter measure really solve the quality issue. Once the process of improvement was validated by hypothesis test, the improvement activity will be implemented as per project planning.

1. Hypothesis Test

The improve phase was conducted once the potential causes of the failure was identified. This phase consists of three steps which are suggestion of the solutions, hypothesis test and implementation. All the three potential root causes of failure for stuck pin was proposed the solution to solve the problem and validate the propose solution by using the hypothesis test. The possible solution was developed through discussion among team members based on the current practice in production processes. The solutions of these three main root causes has been agreed by team members and the solution for the problem of unstable winding machine is setting of the height of shaft into opposite direction of the current setting to avoid from the over or under winding. The second problem is the height of shaft of stop pin in soldering process by additional process of checking the stop pin before soldering the leg to ensure the stop pin in the right track instead of soldering without proper checking. While, the problem of the bobbin assembly method is seggration of the upper bobbin and lower bobbin avoiding from the mixing which is will cause the stuck pin because of the different height of the both bobbins.

From these three possible solutions, hypothesis test was conducted to comparing the result of defects between current practices and proposed solution. The hypothesis has been applied to compared the result of the experiment (P value) with percentage of error (alpha, α) as per simulated by Minitab software. The rule of the hypothesis test is, if the P value < alpha, α; means have a significant factor contributing to the failure of the part. Based on the hypothesis test result, found the bobbin assembly method is not significant factor contribute to the failure because of not found any different between current practice and proposed solution but unstable winding machine and height of shaft was found significant factor and both of the factor have been improved based on proposed solutions. The results hypothesis test for both factors shows in Fig. 7 and Fig. 8.

Hypothesis Test: Chi-Square

Data collection:

	Situation A	Situation B
Accept :	236	240
Reject :	4	0
Total :	240	240

**Remarks:

Situation A : No checking the stop pin condition before winding (if machine down during winding)

Situation B : Check the stop pin condition before winding (if machine down during winding)

Hypothesis Test: Chi-Square

STEP 1:

Ho : Result from Situation A **equal to** Situation B

Ha : Result from Situation A **NOT equal** to Situation B

STEP 2:

Alpha, α = 0.05

STEP 3:

P_{value} = 0.044

Alpha, α = 0.05

P_{value} < alpha, α ; Reject H_o, Accept H_a

If: Pvalue > α; accept Ho, reject Ha
Pvalue < α; Reject Ho, accept Ha

Conclusion:

Result from Situation A is NOT equal to Situation B.

➢ **Situation B does not contribute to Stuck pins**

Fig. 7. Hypothesis test for unstable winding machine

Hypothesis Test: Chi-Square

Data collection:

	Setting A	Setting B
Accept :	473	479
Reject :	7	1
Total :	480	480

**Remarks:

Setting A : 7.1 + 0.15mm (UPPER SIDE)

Setting B : 7.1 - 0.15mm (LOWER SIDE)

Hypothesis Test: Chi-Square

STEP 1:

Ho : Result from Setting A **equal to** Setting B

Ha : Result from Setting A **NOT equal** to Setting B

STEP 2:

Alpha, α = 0.05

STEP 3:

P_{value} = 0.033

Alpha, α = 0.05

P_{value} < alpha, α ; Reject H_o, Accept H_a

If: Pvalue > α; accept Ho, reject Ha
Pvalue < α; Reject Ho, accept Ha

Conclusion:

Result from Setting A NOT equal to Setting B.

➢ **Setting B is better than setting A**

Fig. 8. Hypothesis test for unstable height of shaft

E. Control Phase

The Control phase is the conclusion of the team's journey. The control phase completes an improvement activity ensures day-to-day processes stay in the meeting quality specification and become standard. This phase includes establishing a scatter plot, monitoring the process capability to ensure always meeting the specification, and provide the proper training into workers to ensure the problem will not appear again in the future and highlighted the lesson learned in production floor to ensure workers not make the mistake. Scatter plot is the technique to monitor any abnormality of the data based on trend of the graph. Instability of the data can be recognized and process capability will be applied to monitor the consistency of the assembly processes. At the end of the improvements, visual of the lesson learned of defects will publish in production work station to alert the workers and ensure the defects will not happen again in future.

1. Scatter Plot

Control phase is the stage to ensure the defects will not appears in future based on DMAI phases. The Scatter plot was applied as main tools to monitor the performance of the production process. The scatter plot has been selected because the data collection based on proportion of reject rate and also under category of attribute data. The scatter plot shows in Fig. 9 for the proportion of the reject rate. The result of the chart, shows the reject proportion was drastically reduced by implementaion in the DMAIC and meeting the target of the improvement activity which is 4% of the reject rate

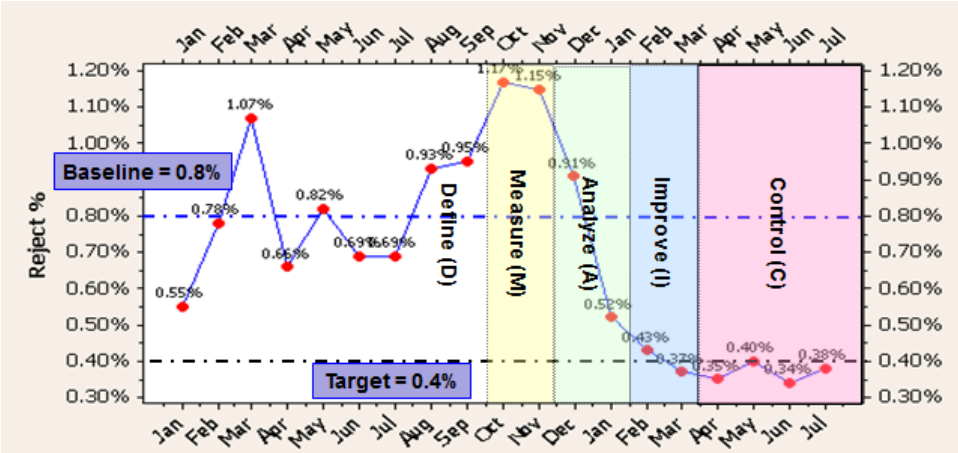

Fig. 9. Scatter plot of the WWG product

2. Process Capability Study

Since the winding process is one of the improvement area, the proccess capability has been re-calculated to ensure the process is capable and the shows in Table V. Based on the the spesificication of the winding wire is 7.1±0.15 mm and improvement has been implementing during improvement stage, the results shows the value of Cp and Cpk drastically improved and the process is capable and meeting customer expectation because the value of Cp and Cpk is > 1.0. The workers will be keep monitoring under On-Job-Training (OJT) system and lesson learned about the previous failure has been published in production floor to ensure the workers are aware about the failure part.

TABLE V. RE-CALCULATING THE PROCESS CAPABILITY STUDY FROM SAMPLE DATA OF THE THICKNESS OF THE WINDING WIRE (IN MM)

7.11	7.11	7.15	7.10
7.15	7.11	7.10	7.12
7.11	7.15	7.18	7.10
7.11	7.10	7.11	7.15
7.10	7.11	7.11	7.15
Mean, μ			7.12
Standard deviation, σ			0.02
Cp			**2.14**
Cpk			**1.84**

IV. DISCUSSION

Defects rate of product plays a very important role for the improvement of yield and financial conditions of any company. Actually defects rate causes a direct effect on the profit margin of the product and decrease the quality cost during the manufacturing of product. Companies strive to decrease the defects rate of the product during the manufacturing processes as much as possible. By checking and inspection of defects of product at different point in a production cycle and management implement some changes specifically at those points in production where more defects are likely to happen. DMAIC model is one of the best emerging approaches for quality assurance and management in automobile parts manufacturing. This paper discussed the implementation of DMAIC methodology in reducing defectives in a car audio manufacturing industry. The DMAIC approach has been used to achieve this result. This paper explains the step-by-step approach of DMAIC implementation in this manufacturing process for improving quality level. Using the suggested DMAIC methodology, the rejection percentage is reduced by 50% from current reject rate. Further improvement in the rejection is expected in the long run after the continuous implementation of all the solutions. With such encouraging result, the team decides to continue doing more improvement project for other products in the future. It also changes the mind set of people to do “fire-fighting method” of tackling the problem.

V. CONCLUSION

In this paper, Six Sigma DMAIC with quality tools has successfully implemented in automotive components manufacturing industry. The DMAIC methodology is one of the method has been adopted in various types of industries because systematic approach to analyze the background of the defects and solving the quality issue step by step. The DMAIC method is defined as project goals and existing processes, measuring of the existing processes, analyze the data to determine the cause-and-effect relationships, improve the current process based on the data control any deviations before product defects occurs. DMAIC methodology helps companies realize that it is a company-wide approach to reducing defects and eliminating product variations. But, the DMAIC methodology is only the platform of the continuous improvement activity with several versions of identification the application tools for every phase. Different type of industry will be using different tools for each phase depending on the type of data collection, data availability, the processes involved and experiences and knowledge of the team members. This paper presents the development of the DMAIC model by identifying the suitable effects tools for each phase with minimized the analysis, but the result shows the high impact into improvement activity. Based on the investigation and implementation of the case study industry, the result shows an adaptation of DMAIC with suitable tools for each phase complements with the quality improvement program

ACKNOWLEDGMENT

This paper was partially supported by finance from Universiti Teknologi Petronas (UTP) and Universiti Kuala Lumpur (UniKL) and also the case study and analysis has been done in automotive parts manufacturing located at Penang.

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