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July 28, 2021

ISIEM

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INDUSTRIAL ENGINEERING DEPT.

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The Conference Program
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Taiwan
1000
Naraphorn Paoprasert, Ph.D
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1030
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1100
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Independent Commissioner
at Garuda Indonesia
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KEYNOTE SPEAKERS

Prof. Yung-Tsan Jou, Ph.D., received his Ph.D. degree in Integrated (ME, ISE) engineering from Ohio University, Athens, OH, in 2003. He is the Chair and Associate Professor of Industrial and Systems Engineering at Chung Yuan Christian University, Taiwan. His research has made contributions in green design, human–system interface design, senior assistive devices, and usability or quality evaluation by using virtual reality tools, smart manufacturing, machine learning, and data analysis.

Naraphorn Paoprasert, Ph.D., is an associated professor at the Department of Industrial Engineering, Kasetsart University, Thailand. She received her Ph.D. from the Department of Industrial Engineering, University of Wisconsin-Madison, USA. Currently, she is a director of the International Graduate Program under the Department of Industrial Engineering. Her past research studies have been focusing on decision analysis and game theory, risk analysis, system simulation, process improvement, and economics analysis. The first research exposures were focusing on decision making to protect the system against natural disasters and terrorism. Later on, the focuses were on decision making in various fields such as agriculture, research fund allocation, education, etc.

Prof. Yun-Chia Liang, Ph.D., received his Ph.D. form Industrial and Systems Engineering, Auburn University – Alabama USA. He actives as Professor and Chair, Department of Industrial Engineering and Management, Yuan Ze University – Taiwan, Vice Director, the Smart Production and Innovation Management Research Center (SPIM), Yuan Ze University, Associate Editor, Journal of Industrial and Production Engineering (JIPE), Planning Committee, IEM Division, Ministry of Science and Technology (MOST), Taiwan, and many more academic activities.

Elisa Lumbantoruan, received Bachelor degree in Institut Teknologi Bandung on Mathematics. He has skill in Business Strategy, Strategic Planning, Business Planning, Business Development, Business Analysis, Risk Management, Management Telecommunications, Business Intelligence, Negotiation.
He experiences in many enterprises and until now is the President Director & CEO at ISS Indonesia, Independent Commissioner at PT Indosat Tbk, and Independent Commissioner at Garuda Indonesia

108	14.20	-	14.30	**Hikmah Fitriani Tamher**, Johnson Saragih and Anik Nur Habyba	Quality Improvement on Pipe Production using Six Sigma and Data Mining in PT. FIP	Universitas Trisakti
135	14.30	-	14.40	Salahaldein Alsadey, Abdelnaser Omran and Zaynab Jamal	Construction Waste Quantification And Benchmarking In Libya	Bani Waleed University,Bright Star University
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Session 1 (13.00 – 15.00)						
Track : Industrial System (IS)						
Session ID:				**S1.5**		
Session Chair:				**Prof. Wei-Jung Shiang**		
Session Parallel:				**Dr. Dino Rimantho /Nur Yulianti Hidayah, ST., MT**		
Paper ID	**Time**			**Name**	**Title**	**University**
73	13.00	-	13.10	**Dino Rimantho**; Indah Lukita Sari and Sodikun	Lean Manufacturing Implementation Strategy in The Pharmaceutical Industry Production Processes: A VSM and AHP Approach	Universitas Pancasila
150	13.10	-	13.20	**Nguyen Thi Xuan Hoa**, Vu Hai Anh, Nguyen Quang Anh and Nguyen Dac Viet Ha	Applying Genetic Algorithm for Capacitated Vehicle Routing Problem and Vehicle Selection-Case Study of Vietnam Logistics Company	Hanoi University of Science and Technology, Vietnam
127	13.20	-	13.30	**Marsellinus Bachtiar** Wahju and Tajuddin Nur	Opportunity and Challenge for Small Wind Power Project in Indonesia	Atma Jaya Catholic University of Indonesia
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69	14.00	-	14.10	Arrys Hadarwan and **Danang Setiawan**	An evaluation of the production risk of broilers day old chicks (DOC) in the hatchery unit using Z Score and Value at Risk	Universitas Islam Indonesia
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out every 0.554 times/month with time interval 955 hours after the last examination with MTTF 2820.01 minutes and MTTR 10.76 minutes with an average maintenance time of 30 minutes. The memory component it is carried out every 0.905 times/month with an interval 519 hours after the last examination with MTTF 6614.72 minutes and MTTR 10.24 minutes with an average maintenance time of 25 minutes. The relay unit component carried out every 1,116 times/month with an interval 401 hours after the last examination with MTTF 6899.4 minutes and MTTR 18.66 minutes with an average maintenance time of 35 minutes.
Keywords: maintenance, performance maintenance, reliability centered maintenance, RCM II, MTTF, MTTR.

13th-ISIEM-Paper 108 – QM

Quality Improvement on Pipe Production Using Six Sigma and Data Mining in PT. FIP

Hikmah Fitriani Tamher[1,a)], Johnson Saragih[1,c)] and Anik Nur Habyba[1,a)]
[1]Department of Industrial Engineering, Universitas Trisakti
Jl. Kyai Tapa 01, Grogol Petamburan, West Jakarta City, Jakarta, Indonesia 11440

Abstract. PT.FIP is an industrial company engaged in manufacturing oil and gas pipelines. PT FIP wants to reduce the product defect percentage by more than 6% in the welding process. This research aims to improve the product quality by using Six Sigma and Data Mining also DMAIC (Define, Measure, Analyze, Improve, and Control) approach. At the Define stage, SIPOC (Supplier-Input-Process-Output-Customer) diagram was used to determine CTQ (Critical to Quality resulted 4 CTQs, namely porosity, hot crack, undercut, distortion. At the measuring stage, the sigma level is 3.54, still, needs to be improved. At the analysis stage, 80% of product defects are dominated by porosity and undercut. Another defect, the hot crack was identified using Ishikawa Diagram and FMEA (Failure Mode and Effect Analyzes). The highest Risk Priority Number (RPN) is porosity caused by a failure in welding conditions and humid pipes, and hot crack is the most significant defect. There is a QC PASS decision standardization with the IF-THEN Rule function from Classification and Regression Tree (CART) at the Improve stage. The improvement was made by applying the welding area cleaning form. After the improvement, the sigma level increase to 3.60.
Keywords: DMAIC (Define, Measure, Analyze, Improve, Control), FMEA (Failure Mode and Effect Analysis), CART (Classification and Regression Tree), six sigma, data mining

13th-ISIEM-Paper 109 – DAIS

Hospitality Food and Beverage Production with ERP System Using Odoo and Rapid Application Development (RAD) Method

Salma Jumaizar Hanif[1,a)], Avon Budiyono[1,b)] and R Wahjoe Witjaksono[1,c)]
[1]Telkom University, Buah Batu, Bandung, Indonesia.

Abstract. The development of the hospitality tourism sector in Indonesia requires the hotel business, especially in XYZ hotels, to improve, apart from managing the existing hotel's lodging service provision system. The need for a planning system to support food and beverage production in hotels is one of the important things to provide satisfaction to customers, both hotel guests and customers outside of hotel guests. The Food and Beverage Department (FnB) is a department that supports operations in processing to serving food and beverages. They have complete responsibility for production activities based on ordering menus and events at the hotel, namely ala-carte and table de'hote. This research focuses on designing a food and beverage production system for managing ala-carte and table de'hote in ERP-based hotels with the Odoo module manufacturing system using the Rapid Application Development (RAD) method. The results of this research are in the form of a system design as a solution needed to support the smooth operation of the FnB department to automate the production planning of table de'hote and production on ala-carte sales. The scheduling, monitoring of production materials selects quality raw materials for star hotels in stores, purchases requests, and produces reports for XYZ hotels.
Keywords: Information Systems, ERP Odoo, Food and Beverage Hospotality System. Manufacturing System, Rapid Application Development (RAD).

https://pubs.aip.org/aip/acp/article-abstract/2485/1/120001/2906018/Quality-improvement-on-pipe-production-using-Six?redirectedFrom=fulltext

Quality improvement on pipe production using Six Sigma and data mining in PT. FIP

Volume 2485, Issue 1
8 August 2023
13TH INTERNATIONAL SEMINAR ON INDUSTRIAL ENGINEERING AND MANAGEMENT
28 July 2021
Bandung, Indonesia

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Quality improvement on pipe production using Six Sigma and data mining in PT. FIP

Hikmah Fitriani Tamher; Johnson Saragih; Anik Nur Habyba
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AIP Conf. Proc. 2485, 120001 (2023)
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PT.FIP is an industrial company engaged in manufacturing oil and gas pipelines. PT FIP wants to reduce the product defect percentage by more than 6% in the welding process. This research aims to improve the product quality by using Six Sigma and Data Mining also DMAIC (Define, Measure, Analyze, Improve, and Control) approach. At the Define stage, SIPOC (Supplier-Input-Process-Output-Customer) diagram was used to determine CTQ (Critical to Quality resulted 4 CTQs, namely porosity, hot crack, undercut, distortion. At the measuring stage, the sigma level is 3.54, still, needs to be improved. At the analysis stage, 80% of product defects are dominated by porosity and undercut. Another defect, the hot crack was identified using Ishikawa Diagram and FMEA (Failure Mode and Effect Analyzes). The highest Risk Priority Number (RPN) is porosity caused by a failure in welding conditions and humid pipes, and hot crack is the most significant defect. There is a QC PASS

UNIVERSITAS TRISAKTI

Anik Nur Habyba <anik@trisakti.ac.id>

13th ISIEM 2021 submission 108

1 message

13th ISIEM 2021 <13thisiem2021@easychair.org> Wed, Apr 21, 2021 at 8:47 PM
To: Anik Nur Habyba <anik@trisakti.ac.id>

Dear Hikmah Fitriani Tamher, Johnson Saragih and Anik Nur Habyba,

We would like to inform you that we already finish reviewing your paper:

Paper : 108
Title : Quality Improvement on Pipe Production Using Six Sigma and Data Mining in PT. FIP

Please find the comment from reviewer below

You can revise your paper at the latest by April 28th 2021

Thank you

Regards,
ISIEM Committee

----------------------- REVIEW 1 ---------------------
----------- Title page - Comply with conference theme; Specific: differentiates this research from other published papers on the subject -----------
SCORE: 1 (Yes)
----------- Author(s) - e-mail address of the corresponding author included -----------
SCORE: 1 (Yes)
----------- Abstract has: background, objectives, methods, result, conclusion in the right order -----------
SCORE: 1 (Yes)
----------- Keywords Contain 3-6 words -----------
SCORE: 1 (Yes)
----------- Title page - Comment -----------
-
----------- Introduction - Clearly state the background that explains the problem -----------
SCORE: 0 (No)
----------- Introduction - Clearly state the problem being investigated (PROBLEM DEFINITION) -----------
SCORE: 1 (Yes)
----------- Introduction - Clearly state the reasons for conducting the research -----------
SCORE: 1 (Yes)
----------- Introduction - Comments for Introduction -----------
The presentation of the object of the case study in introduction is too long. The case study is introduced to solve the research problem but now the introduction suggests that the problem of one company going to be solved. Please more emphasis should be placed on the gap in theory and previous study. I also miss a paragraph in the study that speaks to the scientific contributions of the study

Please check the grammar and the use of appropriate capital letter.
Example:
FIP classifies defects into two types, namely "Reject Products" and "Reworked Products".
Table 1 "Showing" the Number of production and percentage of defects in pipeline products from April to July 2020.

----------- Research method - If there are an algorithm, formulation, flowchart, etc., it should be explained clearly -----------
SCORE: 0 (No)
----------- Research method - Explain briefly about the data collection process -----------
SCORE: 0 (No)
----------- Research method - Comment -----------
There is no an algorithm, formulation, flowchart, etc., it should be explained clearly.
Explain briefly about the data collection process
----------- Result and discussion - Accompanied by tables, figures, charts which present data -----------
SCORE: 1 (Yes)
----------- Result and discussion - State limitations -----------
SCORE: 0 (No)
----------- Result and discussion - Suggest recommendation -----------
SCORE: 1 (Yes)
----------- Result and discussion - Comments -----------
All important points should be discussed (e.g., limitations, future studies, etc)
I also miss a section on the implications or contributions of the study. Please provide the scientific contribution (both theoretical and practical implications of the study.
----------- Conclusion - Summarize this research -----------
SCORE: 1 (Yes)
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The conclusions should be justified by results found in the study
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SCORE: 1 (Yes)
----------- References: Cite primary sources (journal article) – last 10 years -----------
SCORE: 1 (Yes)
----------- References - Comment -----------
The references are too limited
----------- Figures & Tables should be in English and captions included in text -----------
SCORE: 1 (Yes)
----------- Language - Tenses and grammar -----------
SCORE: 1 (poor)
----------- Figures,Tables & Language - Comment -----------
-
----------- Overall evaluation -----------
SCORE: 0 (borderline paper)
----- TEXT:
-
----------- Reviewer's confidence -----------
SCORE: 5 ((expert))

---------------------- REVIEW 2 --------------------
---------- Title page - Comply with conference theme; Specific: differentiates this research from other published papers on the subject -----------
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----------- Author(s) - e-mail address of the corresponding author included -----------
SCORE: 1 (Yes)
----------- Abstract has: background, objectives, methods, result, conclusion in the right order -----------
SCORE: 0 (No)
----------- Keywords Contain 3-6 words -----------
SCORE: 1 (Yes)
----------- Title page - Comment -----------
The abstract should consist of background, objective, method, result, and conclusion in this order. In your Abstract, the conclusion cannot be seen clearly
----------- Introduction - Clearly state the background that explains the problem -----------
SCORE: 1 (Yes)
----------- Introduction - Clearly state the problem being investigated (PROBLEM DEFINITION) -----------

SCORE: 0 (No)
----------- Introduction - Clearly state the reasons for conducting the research -----------
SCORE: 1 (Yes)
----------- Introduction - Comments for Introduction -----------
Please mention the problem statement clearly

Please mention the objective clearly

Please move explanation about detail approach to Methods (ex: Paragraph 3-4)
----------- Research method - If there are an algorithm, formulation, flowchart, etc., it should be explained clearly -----------
SCORE: 0 (No)
----------- Research method - Explain briefly about the data collection process -----------
SCORE: 1 (Yes)
----------- Research method - Comment -----------
Please add citations to support some statements in the Methods

Please add the information about the objects (Welding process), for example about the brief production process, a quality problem that mainly occurred, etc).
----------- Result and discussion - Accompanied by tables, figures, charts which present data -----------
SCORE: 1 (Yes)
----------- Result and discussion - State limitations -----------
SCORE: 0 (No)
----------- Result and discussion - Suggest recommendation -----------
SCORE: 0 (No)
----------- Result and discussion - Comments -----------
Please explain how to calculate the DPMO in 3.2 (type it in the Methods section).

Please make sure you use all English words (ex: “Porositas” and “Distorsi” in 3.3, “Ya” dan “Tidak” di figure 2).

“Figure 5 shows that the Area Under Curve values…”. May be u mean Figure 4

In section 3.3, please explain the function and important finding of ROC and AUC. And explain where do the numbers (0.8421 0.8906, 07448) come from or calculate?

Please do not only focus to mention the result. Please add the discussion regarding the real problem (evaluate results, suggest recommendations, compare with current condition, state limitation, and summarize the findings in an orderly and logical sequence).
----------- Conclusion - Summarize this research -----------
SCORE: 0 (No)
----------- Conclusion - Comment -----------
Please make the conclusion in sentences, not in points.

Please make a more compact conclusion. Focus on the main findings. Mention the contribution, suggest potential areas of further research.
----------- References: All references should be cited -----------
SCORE: 1 (Yes)
----------- References: Cite primary sources (journal article) – last 10 years -----------
SCORE: 1 (Yes)
----------- References - Comment -----------
Please add more references, especially from current issue journals
----------- Figures & Tables should be in English and captions included in text -----------
SCORE: 0 (No)
----------- Language - Tenses and grammar -----------
SCORE: 2 (fair)
----------- Figures, Tables & Language - Comment -----------
Please make sure you use all English words (ex: “Porositas” and “Distorsi” in 3.3, “Ya” dan “Tidak” di figure 2).

There are some mistakes in grammar and tenses. It is suggested to use past tenses to explain the past research, methods, and results. It is suggested to use a prood reader

----------- Overall evaluation -----------
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----- TEXT:
The article is interesting. Please improve the discussion so the article is more meaningful, not only presenting the results
----------- Reviewer's confidence -----------
SCORE: 4 ((high))

RESEARCH ARTICLE | AUGUST 08 2023

Quality improvement on pipe production using Six Sigma and data mining in PT. FIP FREE

Hikmah Fitriani Tamher; Johnson Saragih; Anik Nur Habyba

AIP Conference Proceedings 2485, 120001 (2023)
https://doi.org/10.1063/5.0104997

Quality Improvement on Pipe Production Using Six Sigma and Data Mining in PT. FIP

Hikmah Fitriani Tamher[b)], Johnson Saragih[c)] and Anik Nur Habyba[a)]

Department of Industrial Engineering, Universitas Trisakti
Jl. Kyai Tapa 01, Grogol Petamburan, West Jakarta City, Jakarta, Indonesia 11440
.
[a)]Corresponding author: anik@trisakti.ac.id
[b)]johnson_saragih@trisakti.ac.id
[c)]hikmahfitrianitamher.hft@gmail.com

Abstract. PT.FIP is an industrial company engaged in manufacturing oil and gas pipelines. PT FIP wants to reduce the product defect percentage by more than 6% in the welding process. This research aims to improve the product quality by using Six Sigma and Data Mining also DMAIC (Define, Measure, Analyze, Improve, and Control) approach. At the Define stage, SIPOC (Supplier-Input-Process-Output-Customer) diagram was used to determine CTQ (Critical to Quality resulted 4 CTQs, namely porosity, hot crack, undercut, distortion. At the measuring stage, the sigma level is 3.54, still, needs to be improved. At the analysis stage, 80% of product defects are dominated by porosity and undercut. Another defect, the hot crack was identified using Ishikawa Diagram and FMEA (Failure Mode and Effect Analyzes). The highest Risk Priority Number (RPN) is porosity caused by a failure in welding conditions and humid pipes, and hot crack is the most significant defect. There is a QC PASS decision standardization with the IF-THEN Rule function from Classification and Regression Tree (CART) at the Improve stage. The improvement was made by applying the welding area cleaning form. After the improvement, the sigma level increase to 3.60.
Keywords: DMAIC (Define, Measure, Analyze, Improve, Control), FMEA (Failure Mode and Effect Analysis), CART (Classification and Regression Tree), six sigma, data mining.

INTRODUCTION

PT. FIP is an industrial company engaged in manufacturing, especially steel-based pipe fabrication. This company is inseparable from defective products that do not meet specifications. PT. FIP classifies defects into two types, namely Reject and Rework Products. Based on interviews conducted with the Quality Control Division, the product with the highest number of productions and defects, is pipe. Therefore, this research is focused on pipe products. The average percentage of defects in pipe from April to July 2020 is 8.17 %, it above the company defect tolerance 6%. PT. FIP must take steps to improve the quality so that the presentation of defects is within the acceptable limits of the company.

The existence of defective products in the company impacts high waste, production costs, and customer satisfaction, especially the welding process that has the most defects. The company has to minimize the defect percentage of the welding process, and the methodology that can be used are Six Sigma. The Six Sigma process will center on problem-solving methodologies with Define, Measure, Analyze, Improve, and Control (DMAIC) stages. This methodology is used by most of Six Sigma Practitioners in the world [1], [2].

Classification and Regression Tree (CART) as part of data mining is used to see the defects that affect reject products the most in welding process. Several previous studies have used six sigma in optimizing the performance of the welding process [3]–[5], but no one has used data mining in the analysis stage. This study used data mining to explore what most significant defects for reject products. Data mining contributes to getting deeper insights into product defect and is a supplement to Six Sigma approach [6].

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The CART algorithm can be used for target variables from the welding process, and the defect categories is categorical data. The classification tree can be used for categorical and regression tree for continuous target variable [7]. Corrective actions were carried out following the root cause of defects in the welding process, and the Control stage recalculated the process capabilities and sigma level in the welding process after the improvement. Overall, these studies highlight the need to address Six Sigma and data mining in pipe industry, significantly to minimize the defect percentage in the welding processes.

METHODS

The research began with the Define stage, which can be seen in **FIGURE 1**. This stage is divided into identified SIPOC (Supplier-Input-Process-Output-Customer) diagrams and determined Critical to Quality (CTQ) from the welding process. SIPOC diagram help to understand the value chain of the critical product [8].

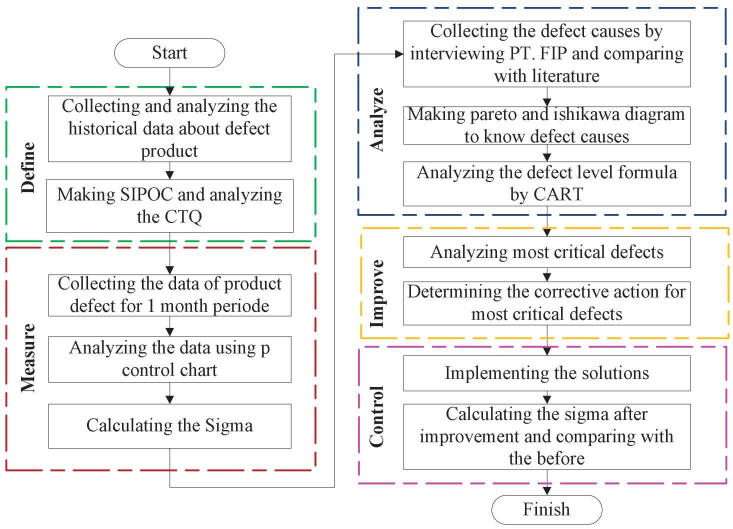

FIGURE 1. Research Framework

It furthermore, calculated the process performance and capabilities using p chart and sigma level at the Measure stage. Control Chart is a traditional tool in Statistical Process Control (SPC) but has good performance in detecting outliers. This statement proved by [9] that Control Chart is more efficient than the Exponentially Weighted Moving Average (EWMA) charts. EWMA chart is suitable for detecting small permanent process changes ranging from 1.5σ to 2σ, while the Control Chart for detecting major changes at the process level. The Defect Per Milion Opportunities (DPMO) of the welding process was calculated by the equation below [10] :

$$\text{DPMO} = \frac{\text{Total number of defects}}{\text{Number of units x Number of opportunities}} \qquad (1)$$

The DPMO score converted to sigma level by Microsoft Excel equation:

$$\sigma = \text{normsinv}\left(\frac{1{,}000{,}000 - \text{DPMO}}{1{,}000{,}000}\right) + 1.5 \qquad (2)$$

At the Analyze stage, Ishikawa Diagram and Pareto Diagram were used to analyze the root cause of the problem. The most significant defects for a reject product was analyzed using classification and regression chart (CART) part of data mining in this study. CART is an effective method in dealing with missing values, especially in this case company data cannot avoid missing values [11]. For CART, the partitioning (splitting) process at each level is guided by a statistical criterion referred to as impurity [12], [13]. One of popular impurity measure is the entropy impurity.

$$i(\tau) = -\Sigma P(c_j)\log P(c_j) \qquad (3)$$

where $P(c_j)$ represents the probability that a product falls into the defect category c_j or the proportion of the products that go into that defect category in node τ. Other impurity is the Gini measure of dispersion. Using $P(c_j)$ to denote the percentage of the products belonging to the defect category c_j (of the dependent variable) in node τ, the Gini measure is

$$i(\tau) = 1 - \Sigma P(c_j)^2 \tag{4}$$

And the last one impurity measure is the misclassification impurity. The misclassification impurity measures is the minimum probability that a case can be misclassified at the node τ.

$$i(\tau) = 1 - \max P(c_j) \tag{5}$$

In the Improve stage, Five W's and One H Analysis was conducted to determine the appropriate corrective action against the most critical defect. The last in the Control stage, DPMO and sigma value between before and after implementation were compared to know if the solution was succesfully reduce the defect or not.

RESULT AND DISCUSSION

Define

Based on Table 1, it can be seen that the production process with the most significant number of defects is in the welding process, with the number of defects during April-July 2020 is 99. Therefore, the welding process on pipe products becomes an essential problem handling focused on this research. Critical to Quality (CTQ) creation is required to see elements critical to quality that can affect customer satisfaction, as in **TABLE 1**.

TABLE 1. Critical to Quality (CTQ)

No	Type of defect	Description	Amount
1	Porosity	Type of defect in the form of a small hole in the steel pipe	61
2	*Under Cut*	type of defect in the form of overdrafts that occur on the base of the steel pipe	22
3	*Hot Crack*	Type of defect in the form of cracks where cracks occur after the welding process is completed	11
4	Distortion	Type of defect in the form of changes in the shape of steel material due to excessive heating during the welding process.	5
		Total	99

The next activity is creating SIPOC diagrams to identify problems based on the production process under review. Mapping the process in this diagram is supported by the production process's input and output in the production process processed in pipe fabrication. Then there is information about related suppliers supporting information to know where the raw materials come from before processing. Also, there is customer information as information on where the process's output results will be continued. Based on Table 2, it can be seen that the pipe comes from PT. CET. The process starts from inspection of raw materials to hydrostatic test to produce a good finish that passes inspection.

TABLE 2. SIPOC Diagram

Supplier	Input	Process	Output	Customer
PT.CET	Uninspected pipe	Raw Material Inspection	Pipes that pass inspection	*Cutting Station*
	Pipes that pass inspection	Cutting	The pipe has been cut	*Bevelling Station*
	The pipe has been cut	Bevelling	The pipe given a tilt angle	*Fit-Up Station*
	The pipe given a tilt angle	Fit-up	Two pipes merged	*Welding Station*
	Two pipes merged	Welding	The pipe has been perfectly fabricated	*Quality control division*
	The pipe has been perfectly fabricated	Radiograph	The pipe that passed the radiography test	*Quality control division*
	The pipe that passed the radiography test	Hydrostatic test	Finish Good with QC PASS label	Customer

Measure

The p-control Chart was used to determine the proportion of defective products to the number of productions. **FIGURE 2** below is the plot of the proportion of defective products. Based on the graph above's plot results above, it can be concluded that the process has been within the Limits of Control. It can be continued with the Calculation of Defects per Million Opportunities (DPMO). The number of productions is 1335 Units, and the number of defects is 110, with 4 CTQ. Returns DPMO value 20600 and can then be converted to a sigma level of 3.54 sigma.

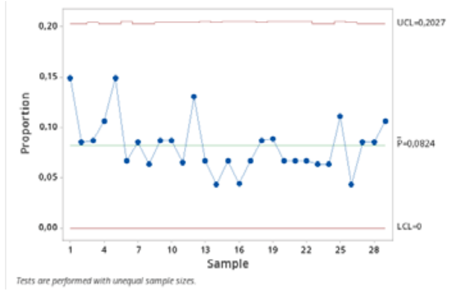

FIGURE 2. P Chart

Analyze

The 4 CTQs obtained at the Define stage were reanalyzed using the Pareto diagram to find out the most dominant type of disability. The Pareto Diagram used the principle of 80-20, where 80% is the most significant disability due to 20% of causes [14]. Based on **FIGURE 3**, it can be known that 83.2% is the cumulative percentage of Porosity and Undercut. In contrast to Pareto diagrams that can only show the most dominant defects based on the frequency of defects in a product, CART helped to see the defects that most affect the reject product.

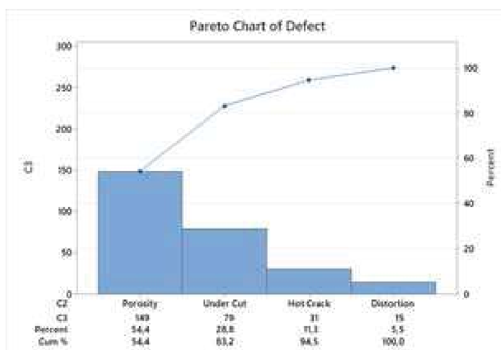

FIGURE 3. Pareto Diagram

Based on observations made until May to August 2020 in the form of rework and reject product data, 102 categorical data were generated to make CART. CART shows that Hot crack is the most significant defect of reject products. To facilitate understanding of the decision tree is made IF-THEN RULES. **TABLE 4** shows IF-THEN RULES as a result of CART.

TABLE 4. IF THEN RULES

No	Rules
1	**If** Under Cut =YES, Hot Crack= YES **Then** Class = REJECT
2	**If** Under Cut =YES, Hot Crack = NO, Distortion=YES **Then** Class = REJECT
3	**If** Under Cut =YES, Hot Crack = NO, Distortion=NO **Then** Class = REWORK
4	**If** Under Cut =NO, Hot Crack = YES **Then** Class = REJECT
5	**If** Under Cut =NO, Hot Crack = NO, DISTORTION= YES **Then** Class = REJECT
6	**If** Under Cut =NO, Hot Crack = NO, DISTORTION= NO **Then** Class = QC PASS

CART accuracy level can be determined from various parameters: the Receiver Operating Characteristic Curve (ROC). Based on **FIGURE 4**, the Area Under Curve (AUC) values for QC PASS decisions and values 0.8421 and 0.8906, which means CART is considered accurate, and rework decisions are worth 0.7448, which means acceptable. In general, the ability to classify product quality with and without the defect characteristics based on the test, 0.7 to 0.8 is considered acceptable, 0.8 to 0.9 is considered excellent, and more than 0.9 is considered outstanding [15]. The AUC combined a measure of sensitivity and specificity that describes the inherent validity of diagnostic tests and effective [16] in classifying the defect level of the product.

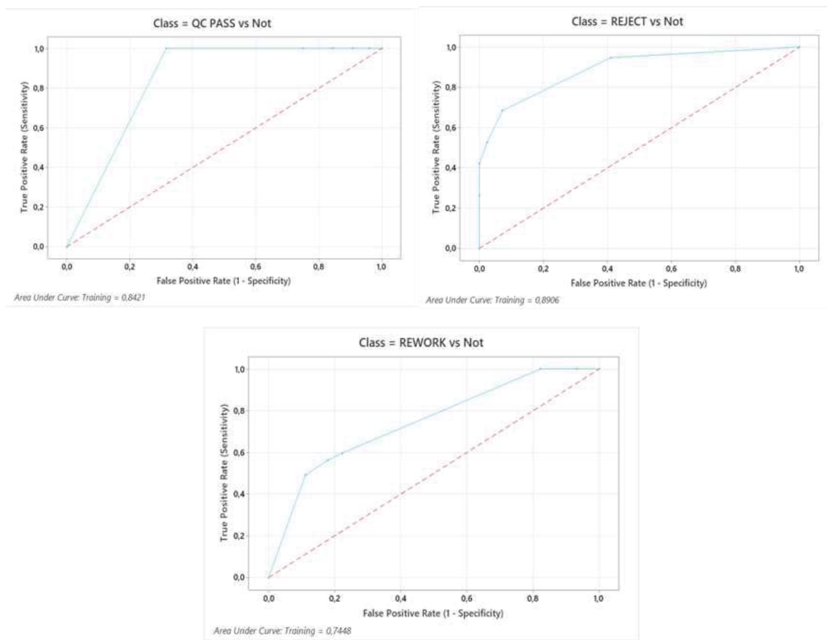

FIGURE 4. *ROC Curves*

Identification of the cause of the defect can be made using the Ishikawa Diagram, as shown in **FIGURE 5**.

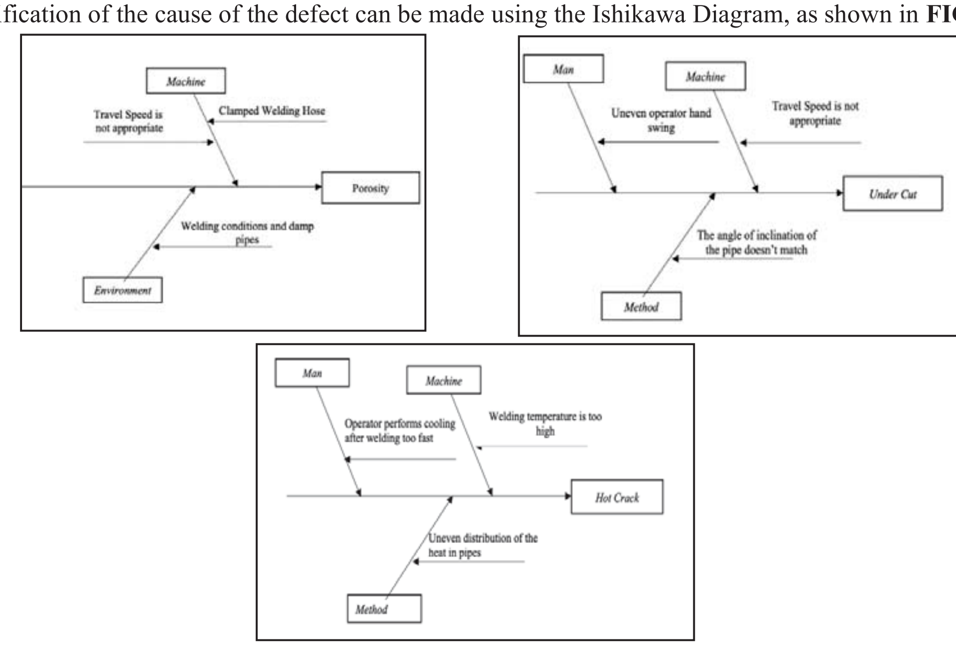

FIGURE 5. Ishikawa Diagram

Once the defect cause was identified, the next step was to determine the cause of the failure prioritized in the corrective action. For severity, occurrence, and detection values for each disability are based on brainstorming results with the head of the Quality Control division. A failure mode with a high RPN number should be given the highest priority in concludes the corrective action [17]. For example, in porosity failure with the cause of weld hose failure pinched, RPN value is a multiplication of Severity, Occurrence, and Detection, multiplication of 7,4 and 4 to produce a value of 112 (**TABLE 5**).

TABLE 5. FMEA Analysis

Process	Potential Failure Mode	Potential Failure Effect	S	Potential Causes	O	Current Process Controls	D	RPN
Welding	Porosity	*rework*	7	Clamped welding hose	4	Hose position check before production	4	112
				Travel speed is not appropriate	5	machine motion speed check	4	140
				Welding conditions and damp pipes	7	pipe cleaning before processing	4	196
	Under Cut	*rework*	6	Travel speed is not appropriate	5	machine motion speed check	4	120
				Uneven operator hand swing	5	Periodic monitoring of operator performance	5	150
				The angle of inclination of the pipe does not match	4	The slope angle of the pipe ranges from 70-80 degrees	5	120
	Hot Crack	*reject*	9	An operator performs cooling after welding too fast	3	Cooling after welding is done slowly	4	108
				Uneven distribution of heat in pipes	3	welding is performed repeatedly	5	135
				Welding temperature is too high	2	Perform heat settings before and during the process	5	90

From the table above, it can be seen that the highest RPN value is in porosity defect. Porosity was prioritized to be given corrective action.

Improve

Five W's and One H Analysis were used to determine the appropriate corrective action against porosity. **TABLE 6** is the result of an analysis focused on porosity defects because it has the highest RPN.

TABLE 6. Five W's and One H Analysis

What	*Where*	Faktor	*Why*	*When*	*Who*	*How*
Porosity	*Welding*	*Machine*	Clamped welding hose	on welding process	Welding machine operator	Monitoring hose positions regularly
			Travel speed is not appropriate	on welding process		Operator checks travel speed during the welding process.
		Environment	Welding conditions and damp pipes	on welding process		Making cleaning routinely form for welding area

Based on **TABLE 6**, one of the causes of porosity is that the welding area and pipes are not cleaned regularly, and there was no record of cleaning done. This caused the pipe dirty and have bubbles that make porosity. Therefore, the proposed improvement to overcome these problems is to make a daily cleaning form. A neat, systematic, and scheduled milling can make it easier for the operator to find out when the machine was last cleaned. The proposed improvement in the form of cleaning form is shown in **FIGURE 6**.

PT. Farrel Internusa Pratama R.Dengklok Street, Karawang district		Cleaning Form Welding Area	
No.	**Name of Area/machine**	**Name of Operator**	**Cleaning date & Time**
Made by : Hikmah Fitriani	**known by :** *Production Spv*	**Personal Protective Equipment**	

FIGURE 6. Cleaning Form

Control

The daily cleaning form is applied to the welding area and filled by the operator in charge. In there, two operators help each other form in the contents 30 minutes before avoiding pipes and dirty areas. The state of clean areas and pipes can prevent defects in the resulting pipes. This form is also a record for the company about the last time the area and pipes were cleaned—from daily cleaning filled by the operator during January 18, 2021, to January 26, 2021. After the implementation, the following process is the Calculation of process performance using the p control map. After implementation, the control chart's Calculation using inspection data for seven days of observation is shown in **FIGURE 7**.

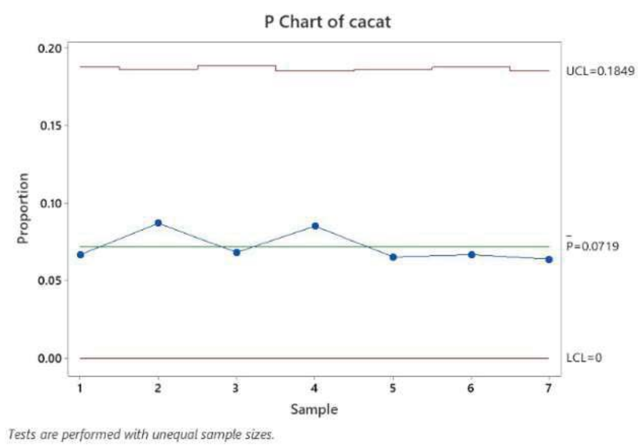

FIGURE 7. P Chart After Implementation

Based on the graph above's pilot results above, it can be concluded that the process has been within the Limits of Control so that it can be continued with the Calculation of Defect per Million Opportunities (DPMO). The production number is 320 Units, and the number of defects is 23, with 4 CTQ. Returns DPMO value 18000 and can then be converted to a sigma level of 3.60 sigma. The sigma value increased after implemented the corrective action, from 3.54 to 3.60 sigma. The increase in sigma was successfully carried out by 0.06. This research helps PT FIP to solve problems in the welding process even though it can only increase the sigma very little. This is because the research was carried out during the COVID 19 pandemic, so that implementation can only be done with a very limited time. In addition, product defect data can only be taken from historical data, not from direct observation due to company policy during the pandemic. The use of the latest data in the future can make the proposed improvements more accurate.

CONCLUSION

Based on data from April to July 2020, there are 4 Critical to Quality or four types of defects contained in pipe products that are fabricated, namely Porosity, Undercut, Hot Crack, and Distortion. The DPMO value of the pipeline product production process before a repair is 20600 defects in one million opportunities, while for sigma level is 3.54 Sigma. Based on measure stage results, the dominant defects cause to reject products, namely Porosity and Undercut, while based on CART is Hot Crack. If based on the FMEA method, a porosity defect with the cause of welding condition and a damp pipe has the highest RPN value of 196, so that the defect will be prioritized to be given a proposed repair. After the implementation of the proposed welding area hygiene form is carried out, and the DPMO value increases to 18000 with a sigma level of 3.60 so that it can be known that there is an increase in sigma level with a difference of 0.06 compared to before implementation. This research was conducted during the COVID-19 pandemic with many limitations. The use of data mining can be used to explore Ishikawa diagrams in determining the critical causes of defects. This will help the company to know the defect classification based on the causative factors.

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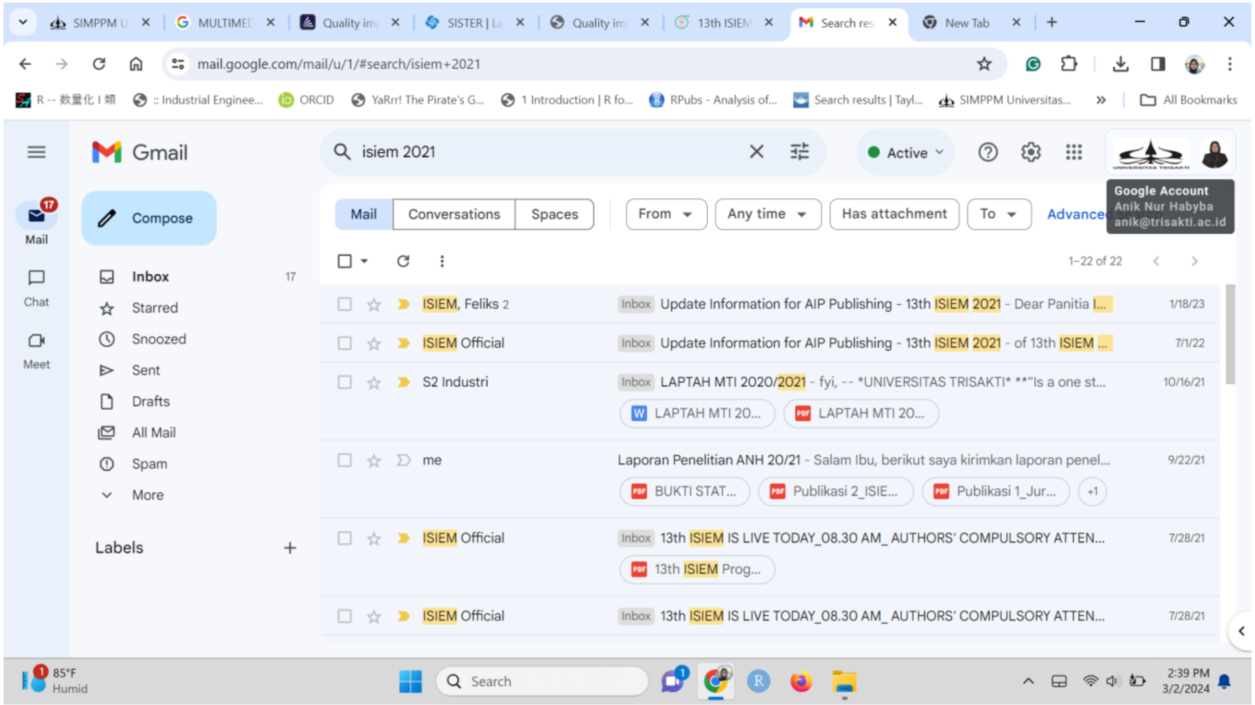
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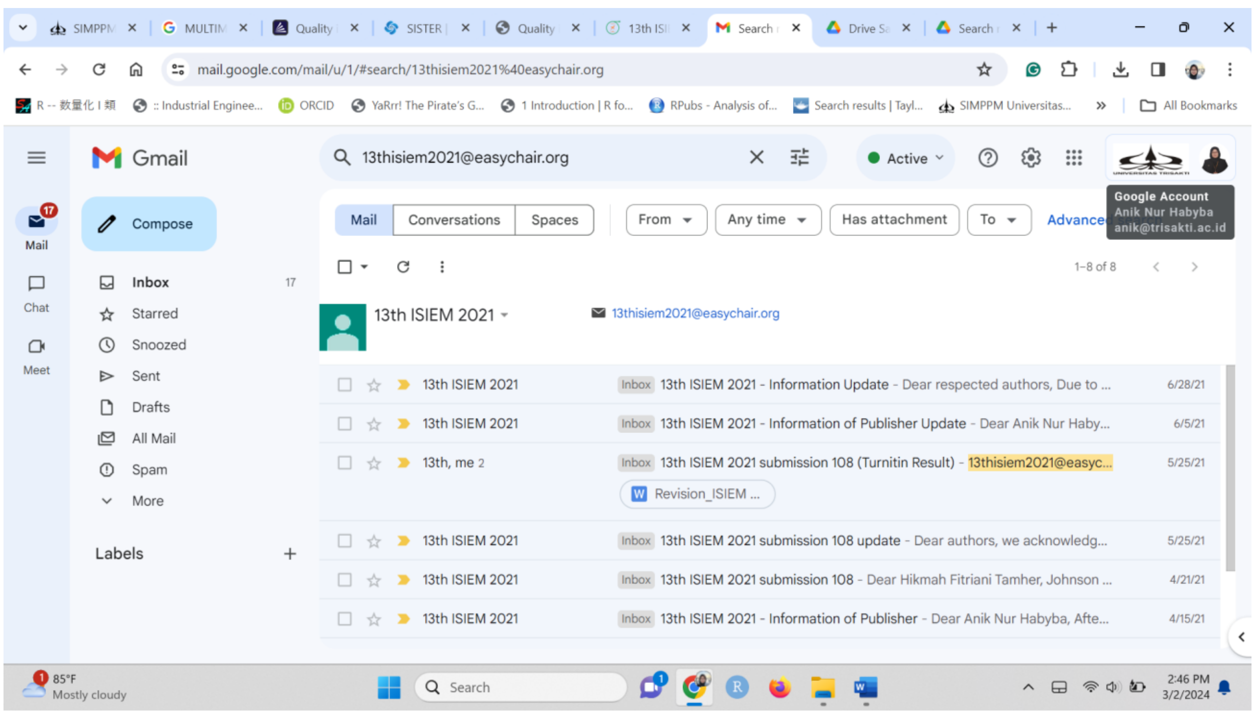
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Dear Respected Authors,

It is a pleasure to inform that your submission (detailed below) is *accepted* at the 13th International Seminar on Industrial Engineering and Management (13th ISIEM). As you are aware of, 13th ISIEM will be held on July 28, 2021 in Bandung, Indonesia.

Author(s)	:	**Hikmah Fitriani Tamher, Johnson Saragih and Anik Nur Habyba**
Title	:	**Quality Improvement on Pipe Production Using Six Sigma and Data Mining in PT. FIP**
Paper Code	:	**108**
Review result	:	**Accepted, with revision**

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On behalf of the Organizing Committee of 13th ISIEM, I would like to *congratulate you for the acceptance of your paper and to thank you for participating in 13th ISIEM.*

Other arrangements regarding the conference will be informed through you or updated through the website. Should you have any inquiry, please do not hesitate to contact us. Looking forward to see you in Bandung for 13th ISIEM.

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