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Analysis of Noodle Production Process at Yan Hu Food Manufacturing: Basis for Production Improvement

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Abstract**—**This study was conducted to analyze the noodle production process at Yan Hu Food Manufacturing for the basis of production improvement. The study utilized the Plan, Do, Check, Act (PDCA) approach and record review in the gathering of data for the calendar year 2019, specifically from August to October, focusing on the noodle products miki, canton, and misua. A causal-comparative research design was employed to establish cause-effect relationships among the variables, using descriptive statistics and correlation to compute the data gathered. The findings indicate that miki, canton, and misua production have distinct cycle times and production outputs in every set of its production processes, as well as varying levels of wastage. The company has not yet established a formal allowable rejection rate for wastage; instead, this paper used a 1% wastage limit. We recommended the following: machines used for each process of the noodle product must be consistently maintained and monitored; an assessment of all the production operators should be conducted by assessing their performance statistically based on the output and the machine performance; a root cause analysis must be conducted to identify solutions to production issues; and, an improved recording system for input and output of the production process of each noodle product should be established to eliminate the poor recording of data.

Keywords**—**Production, continuous improvement, process, operations, Plan, Do, Check, Act approach.

I. Introduction

IN today's world, food production, security, and sustainability are critical global priorities. As the population grows, efforts to boost food production have led to a troubling increase in food waste, raising significant environmental concerns about its disposal. This challenge has sparked a growing interest in sustainable practices and innovative strategies to valorize food waste, which is increasingly seen as a renewable resource rich in organic materials. However, unlocking this resource requires the development of novel manufacturing techniques and the re-engineering of existing methods to maximize its benefits. In the modern world, food production, security, and sustainability are vital global priorities [1]. The ongoing effort to increase food production to satisfy the demands of a world population that is expanding has unintentionally resulted in a significant rise in food waste [2]. There are serious environmental issues with how to dispose of this growing amount of food waste [3]. As a result, there has been a discernible increase in interest in promoting environmentally responsible, sustainable practices as well as cutting-edge tactics meant to valorize food waste. Food waste is increasingly recognized as a renewable resource primarily composed of organic materials that can be converted into various value-added products. These products may encompass medications, bioactive substances, and biofuels. However, to unlock the full potential of this largely untapped resource, it is imperative to develop novel manufacturing techniques. Additionally, enhancing present methods through re-engineering is crucial for optimizing the benefits provided by food waste.

According to Thamagasorn et al. [4], an analysis of food waste from a flight catering business for sustainable food waste management reveals that the airline industry requires a large capital investment and is highly dependent on resources. An examination of the composition and generation of food waste has identified specific types of food discarded in substantial quantities. As highlighted by Garrone et al. [5], the Food Waste Hierarchy emphasizes that effectively utilizing unsold food should be a top priority. However, there remains a lack of comprehensive understanding regarding the root causes, strategies, and operational processes that enable businesses to successfully address this priority. This paper aims to elucidate the strategies through which food producers can proactively prevent surplus food from spoiling and turning into waste. The central goal of this study is to investigate and articulate the factors, tactics, and operational procedures that empower these businesses to transform excess produced food into profitable resources rather than allowing it to go to waste. In addition, this work presented a coherent integration between the goals of waste reduction and improved food security.

The case study was carried out at Yan Hu Food Manufacturing, a Philippine company known for its production of a variety of traditional wet and dry noodles, including 'Fresh Miki,' 'Pancit Canton,' 'Dried Miki,' and 'Misua.' Unfortunately, Yan Hu Food Manufacturing lacks proper documentation of historical data. Consequently, the observation about production deviations at YHFM may be attributed to several factors:

Enhancing the miki, canton, and misua noodle production process involves:

- Establishing standard times for each production process.
- Identifying the main factors contributing to wastage in the production of canton, misua, and miki.

Effective monitoring and analysis of production involves:

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- Implementing proper monitoring and analysis of canton, misua, and miki production in each process.

Areas for process improvement include:

- Analyzing and recording wastage for each product (miki, misua, canton) in terms of both kilograms and cost.
- Improving work-in-process by developing standard operating procedures for each process.
- Enhancing production output in each process and optimizing raw material usage.

Yan Hu Food Manufacturing Inc. is currently dealing with a critical issue of food waste generation, with a total wastage of 5,146.23 kg, valued at 144,094.44 Philippine Peso (Php), in the production of miki, misua, and canton, based on data from September to October 2019. The objectives of this study are as follows:

1. *Production Analysis:*
   - Evaluate production outputs.
   - Examine production process cycle times.
   - Calculate the average cycle time.
   - Assess wastage incurred per product.
2. *Financial Cost Implications:* Identify the financial costs associated with the wastages in the manufacturing of miki, canton, and misua noodles.
3. *Problem Resolution:* Propose solutions to address the identified problems using problem-solving techniques. Utilize root cause analysis to identify the underlying causes of wastages.
4. *Statistical Analysis:* Determine, through statistical tools, if there is a significant relationship between the average cycle times in the manufacture of noodle products and their corresponding wastage.
5. *Recommendations:* Provide recommendations to mitigate the financial costs of production wastage specifically in the manufacturing of miki, canton, and misua at Yan Hu Food Manufacturing Inc.

By addressing these objectives, the study aims to offer a comprehensive understanding of the production challenges, financial implications, and potential solutions for Yan Hu Food Manufacturing Inc.

II. Background of the Study

A. Research Paradigm

The research paradigm employs the IPO model (Input-Process-Output) to structure the study. The Input phase involves examining data from previous records, which were meticulously checked, compared, and analyzed. This analysis aimed to identify problems within the production yield. Concurrently, monitoring the live production process served to validate the recorded data and verify the actual processes in place. The Process stage involves the thorough analysis of the production process to identify and address the identified issues. The goal was to reduce waste and enhance the overall production process. Anticipated outcomes include improved production output, reduced cycle time in each process, and decreased wastage in terms of cost. The resolution of these issues is expected to contribute to the overall enhancement of the entire production process.

Yan Hu Food Manufacturing Inc. currently experiences total wastage of 5,146.23 kg, valued at 144,094.44 Php in its production of miki, misua and canton noodles, based on data for the period of September to October 2019. The objectives of the study include analysis of production outputs, production process cycle times, average cycle time, and wastage incurred for each product -- miki, canton, misua noodles. Additionally, the study aims to identify the financial cost implications of these wastages with respect to the production process. A root causes analysis was conducted to identify the causes of wastage and develop solutions to the problem using problem-solving techniques. Statistical tools were utilized to identify whether a significant relationship exists between the average cycle times in the manufacture of noodle products and the corresponding wastage. Finally, the study presents recommendations aimed at addressing the financial costs with production wastage at Yan Hu Food Manufacturing Inc., specifically for the manufacture of miki, canton, misua noodles.

B. Theoretical Framework

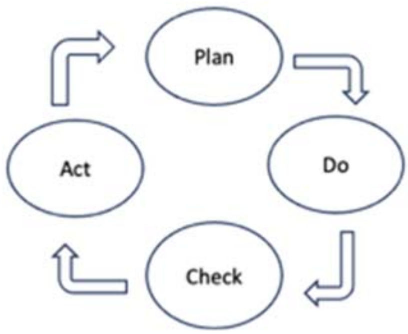

Fig. 1 Plan, Do, Check, Act

The conceptual framework depicted in Fig. 1 outlines the analytical tool used to develop a comprehensive understanding of this paper. The PDCA Cycle serves as the structured methodology employed to gather insights and information for continuous process improvement [6]. PDCA is a cyclical four-step process commonly applied to enhance quality and productivity in business strategies. The framework operates as follows: Plan — recognize the opportunity and plan change based on the problem statement and objectives: Do — test the areas needed to change and improve; Check — review the test area, analyze the results, and identify what to implement; Act — take action based on what is needed for the improvement: If the change does not work or needs to be updated and to be improved more, the cycle goes through again with a different and a new plan. In Fig. 1, the arrows represent the continuous direction of the cycle of PDCA [7]. This paper utilizes a PDCA approach to address the problem by analyzing daily production data, examining each production process, and evaluating product wastage in kilograms and pesos for canton, misua, and miki noodles.

III. Research Methodology

The study relies on secondary data, specifically the company's previously recorded information. These secondary data encompass daily production records, each production process for canton, misua, and miki, as well as product wastage in kilograms and pesos at each process for noodle product. The study conducts a retrospective review of records from Yan Hu Food Manufacturing Inc., focusing on production and wastage of canton, misua, and miki. This design uses pre-recorded data from written documents, contributing valuable insights for future processes.

In applying the Quality Management principle of PDCA, the study addresses identified issues. Data gathering involves an actual visit to the company, obtaining permission for data access, and observing the production process. A revisit to the plant, inspection of the production area, and records review help identify problem areas, such as input-output relations and wastage in each production process.

1. Plan:
- Define the problem: Identify specific areas of production and types of wastage within the manufacturing process of canton, misua, and miki noodles.
- Set objectives: Establish measurable goals for reducing wastage and improving production efficiency, such as minimizing material loss and increasing output.
- Develop a plan: Outline strategies for data collection, analysis, and implementation of improvement measures, considering the retrospective review of records.
2. Do:
- Implement the plan: Collect relevant data from production records, including production outputs, cycle time and instances of wastage.
- Apply statistical analysis: Utilize correlation analysis to identify relationships between production variables and wastage levels. Implement ANOVA to assess variations in production and wastage among different noodle types. Use t-tests to compare means and evaluate the effectiveness of interventions.
3. Check:
- Evaluate results: Analyze the findings from the statistical analyses to assess the impact of production processes on wastage reduction and output improvement.
- Assess statistical findings: Interpret correlation coefficients, ANOVA results, and t-test outcomes to determine the significance of relationships and variations observed.
4. Act:
- Take corrective actions: Based on the insights gained from the data analysis, identify areas for process improvement and waste reduction.
- Implement changes: Adjust production processes, quality control measures, or resource allocation to address identified issues and improve overall efficiency.
- Monitor and continuously improve: Establish monitoring mechanisms to track production and wastage metrics over time. Iterate the PDCA cycle as needed to sustain improvements and address emerging challenges.

By applying the PDCA cycle along with statistical analysis techniques such as correlation, ANOVA, and t-test to the retrospective review of production and wastage records, Yan Hu Food Manufacturing Inc. can systematically identify opportunities for improvement, implement targeted interventions, and achieve measurable enhancements in production efficiency and waste reduction across its noodle product lines.

A. Statistical Treatment

Statistical treatment of data in this study is an application of a statistical method to the data gathered and transform it from a group of meaningless numbers into an expressive output.

Statistical analysis was required for each process of canton, misua, and miki at Yan Hu Food Manufacturing Inc. The necessary data are the input and output figures, as well as the wastage generated during the production of canton, misua, and miki noodles.

B. Quality Tools

To support the statistical analysis, Pareto analysis was employed to evaluate the list of scrap in the production wastage. The Pareto method helped identify the vital few problems that significantly impacted each process, based on scrap classifications of wastage for canton, misua, and miki production. For a deeper analysis, the Fishbone diagram (Cause and Effect diagram) was used to explore the cause and effect of each identified problem. The insights from the Fishbone diagram were instrumental in conducting the root cause analysis of the problem, ultimately leading to identification of possible solutions to the production problems [8].

C. Equations

Statistics were employed to address the hypotheses presented in the study. Data from reviewed records were tabulated and analyzed using descriptive statistics and correlation. Average differences in cycle time and wastages versus quantity produced were identified.

Correlation is used to examine the relationship between cycle time and wastage (Y) and production output (X) [9]. By applying correlation analysis to the retrospective review of production and wastage records, Yan Hu Food Manufacturing Inc. can gain valuable insights into the factors influencing wastage levels across its noodle product lines, enabling informed decision-making and targeted interventions to enhance production efficiency and reduce waste. Positive correlations suggest that as one variable increases, the other also tends to increase, while negative correlations indicate an inverse relationship.

The t-test is a statistical technique employed to ascertain whether significant disparities exist between the averages of the two groups. In this manufacturing research context, it can compare the means of different process parameters, materials, or production techniques to assess their impact on product quality or performance. By collecting data from manufacturing processes and applying the t-test, the study can determine whether observed differences in outcomes are statistically significant or due to chance [10]. In researching the enhancement of miki, canton, and misua noodle production processes, the t-test can be valuable for:

- *Optimization of Cycle Time:* We are identifying statistically significant improvements by correlating cycle time with wastage to uncover a significant relationship between these two variables.

- *Production Wastage:* When adjusting process parameters such as mixing time, resting time, or drying temperature, the t-test can assess the impact of these adjustments on the quality and consistency of the noodles. By comparing the of noodles produced under different process conditions, it can determine if the changes are statistically significant.

Overall, the t-test can serve as a powerful analytical tool in the research and development of enhanced miki, canton, and misua noodle production processes, aiding in the identification of statistically significant improvements in quality, efficiency, and consumer satisfaction.

ANOVA, or Analysis of Variance, is a robust statistical technique commonly employed in manufacturing research studies. This study uses ANOVA to analyze variations in the two groups. It facilitates the examination of variations across multiple factors like process parameters, production output, and cycle time. Through the comparison of group means and the evaluation of within-group variability, ANOVA aids in identifying significant differences. This insight supports informed decision-making in process enhancement, quality assurance, and product innovation [11].

- *Identifying Interaction Effects:* ANOVA can identify interaction effects between different factors that may affect cycle time and wastage simultaneously, such as production times. Understanding these interactions can guide more targeted process improvement efforts.

Overall, ANOVA provides a comprehensive framework for analyzing the impact of production variations, process parameters, and improvement initiatives on cycle time and wastage reduction in miki, canton, and misua noodle production processes, helping to optimize efficiency and resource utilization.

$$r = \frac{N\sum xy - \sum x \sum y}{\sqrt{(N\sum x^2 - (\sum x)^2)(N\sum y^2 - (\sum y)^2)}} \quad (1)$$

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad (2)$$

$$F = \frac{MS_{group}}{MS_{error}} \quad (3)$$

IV. Results and Discussions

The SIPOC process is employed to represent each step of the process for each product. The analysis covers several key aspects:

- *Production Outputs:* Evaluation of the production output for each product (miki, canton, misua) based on complete data from August to October 2019, pre-pandemic [12].
- *Average Cycle Time:* Determination of the average cycle time for each product (miki, canton, misua) per process [13].
- *Wastage Analysis:* Examination of wastage per product and per month, including its average [14].
- *Financial Cost Analysis:* Assessment of the financial cost of YHFM products (miki, canton, misua) attributed to wastage.
- Utilization of cause-and-effect diagram and root cause Analysis for deeper insights into wastage causes.

In extending the analysis, consideration is given to potential quality tools to identify waste within the company. This involves a detailed exploration of the extent of wastage in noodle production (miki, canton, misua) through Pareto Analysis and Root Cause Analysis, employing Ishikawa Diagrams [15].

A. Noodle Production Output

Production outputs refer to the goods produced by Yan Hu Food Manufacturing Inc. within a specified time period. These goods can either be consumed directly or used for further production (miki, canton, misua). The production outputs represent the noodle product created through the collaboration of labor and machinery at Yan Hu Food Manufacturing Inc.

TABLE I
Production for the Month of August to October (2019)

Month 2019	Miki (Kg)	Canton (Kg)	Misua (Kg)	Total (Kg)
August	77,492	55,144	9,973	142,609
September	69,104	54,380	11,982	135,466
October	63,816	63,852	12,247	139,915
Total (Kg)	210,412	173,376	34,202	417,990

Table I shows the total production per product for the months of August to October 2019, with units in kilograms. Based on the table, the production data reveal varying outputs each month. In total, miki has the highest production output at 210,412 kg, followed by canton with a total of 173,376 kg, while misua has a production of 34,202 kg for the period from August to October 2019. In September, there is an increase in production demand for misua compared to August, and in October, there is also an increase in production output for both misua and canton compared to September.

B. Average Production Cycle Time

The Average Cycle time is the time average used to take to complete the production process to finish the one unit of product. The cycle time has different measurement from start to finish depending on the product and processes.

TABLE II
Average Cycle Time of Each Product

Product	Total Cycle Time		
	(Seconds)	(Minutes)	(Hours)
Miki	294	4.90	0.0817
Dried Miki	21,305	355.08	5.9181
Misua	18,440	307.33	5.1222
Canton	493	8.22	0.1369

Table II presents the average cycle time for each process of every product, measured in seconds. Each product exhibits a unique cycle time, and certain products do not undergo certain processes due to variations in their process flow. In general, the kneading process across all products is characterized by a lengthy cycle time, while weighing consistently has the fastest cycle time.

For various products, there are distinct cycle times. For instance, the production process for miki does not include drying by fan, frying, and oven-drying, hence there is no recorded cycle time for these processes. This is because dried miki does not undergo cooking, boiling, or drying by the stick process. On the other hand, dried miki and misua both undergo the drying fan process, which takes a longer time. Notably, the oven process for misua takes the longest time among all the processes involved.

C. Wastage Incurred

At Yan Hu Food Manufacturing Inc., wastage refers to the materials discarded due to various factors such as labor, machine, methods, and materials. The wastage incurs costs that are ultimately not covered by the customer.

TABLE III
COMPUTATION OF THE TOTAL WASTAGE PER PRODUCT IN KILOGRAMS

Month 2019	Miki	Canton	Misua	Total
August	438.94	902.71	287.03	**1,628.68**
September	500.54	759.93	413.08	**1,673.55**
October	319.93	1,232.27	291.80	**1,844.00**
Total	**1,259.41**	**2,894.91**	**991.91**	**5,146.23**

Table III represents the total wastage, measured in kilograms for each product. Among the three products, canton has the highest wastage, totaling 2,894.91 kg over three months from August to October 2019. Miki follows with 1,259.41 kg, while misua has lowest wastage weight of 991.91 kg. The higher wastage in canton can be attributed to its more complex production processes.

D. Financial Cost Implication

Wastage in financial terms refers to the loss of raw materials during the production process, calculated in pesos. This may involve losses due to different kinds of waste that it considered as scrap or non-conforming products. To assess the specific financial impact of these losses, the costs are calculated based on the standard price of the raw materials used in the production of the products.

TABLE IV
SUMMARY COMPUTATION OF WASTAGE IN KILOGRAMS AND PESOS PER MONTH

Summary Computation	Wastage (kg)	Wastage (in Philippine pesos, ₱)
August 2019	1,628.68	45,603.04
September 2019	1,673.55	₱ 46,859.40
October 2019	1,844.00	₱ 51,632.00
Total wastage	**5,146.23**	**₱ 144,094.44**
Average wastage per month	1,715.41	₱ 48,031.48
Average wastage per year (₱)	576,377.76	

Table IV shows the summary computation of wastage in kilograms and pesos per month. Each sack of flour weighs 25 kg of weight, with an average cost of 700 Php per sack. The monthly financial losses for Yan Hu Food Manufacturing Inc. are as follows: 45,603.04 Php for August 2019, 46,859.40 Php for September 2019, and 61,632.00 Php for October 2019. Based on these data and assuming consistent demand, the moving average indicates a potential annual average wastage cost of 576,377.76 pesos for Yan Hu Food Manufacturing Inc., representing a significant expense for a small food manufacturing company.

E. Problem Solving Technique

This paper employs the following problem-solving techniques: Pareto Analysis, Fishbone Diagram, and Root Cause Analysis. The Pareto Diagram is a fundamental quality tool that aids Yan Hu Food Manufacturing Inc. in identifying the most frequent wastage or defects occurring in each product. It helps in counting and categorizing factors to prioritize solutions. The Pareto Diagram applies the 80/20 rule, stating that for many events, 80% of the effects come from 20% of the causes [16].

The Cause-Effect Diagram, also known as a Fishbone or Ishikawa diagram, is a visual tool used to systematically organize potential causes for a specific problem or effect. It vividly illustrates the factors influencing the problem in detail.

Root Cause Analysis employs the Why-Why Analysis, a comprehensive approach that encompasses various methods, tools, and techniques to uncover the causes of problems. It investigates the roles of man, machine, methods, and materials in the occurrence of issues [17].

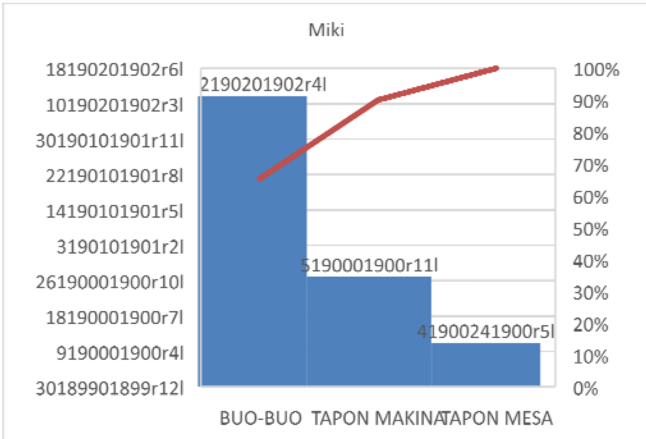

Fig. 2 Pareto diagram of scrap wastage in miki production

Fig. 2 shows the Pareto diagram of scrap wastage of miki, highlighting the need to prioritize solutions for the "Buo-Buo" issue. Based on the 80/20 rule of Pareto, where 80% of effects come from 20% of causes, "buo-buo" wastage accounts for 823.25 kg over three months, contributing more than 65.37% to the overall problem in miki. In comparison, "tapon sa makina" contributes 24.68% and "tapon sa mesa" contributes 9.94% to the total wastage in miki.

Fig. 3 illustrates the causes of the "buo-buo" defect in miki production, categorized by man, machine, material, and method. The identified causes include poor quality of materials, improper mixing, issues with the mixing machine blade, and the operator's failure to detect problems.

Fig. 4 presents the Pareto diagram of scrap wastage for canton, highlighting the need to prioritize solutions for "tapon Mesa" and "sunog." According to the 80/20 rule, "tapon sa mesa" accounts for 1,233.87 kg over three months, contributing more than 42.62% to the overall wastage in canton. "Sunog" follows closely as the second to the highest contributor, making up 41.24%. Other contributors include “durog” at 11.61% and an additional 4.53% for other wastage types.

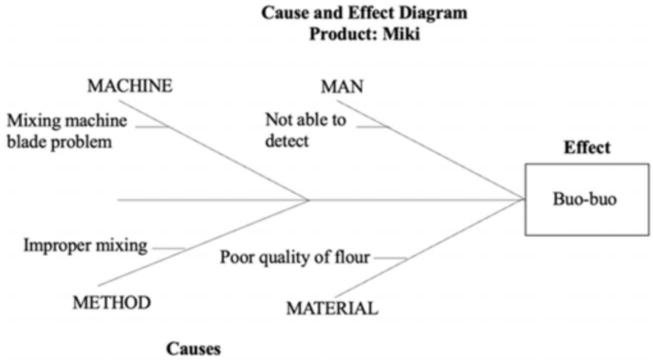

Fig. 3 Cause and effect diagram of scrap wastage in miki production (*buo-buo or solid material)*

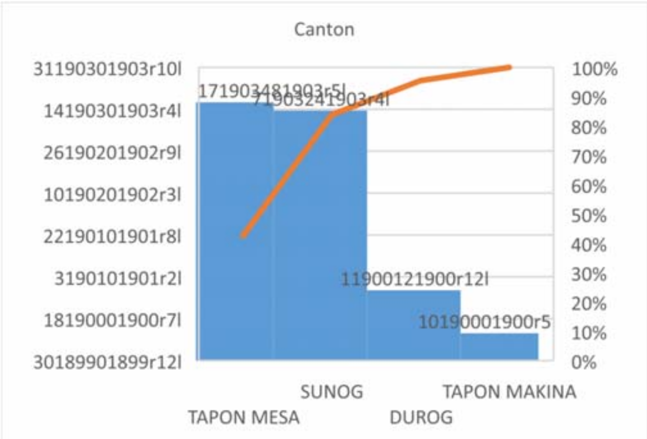

Fig. 4 Pareto diagram of scrap wastage in canto production

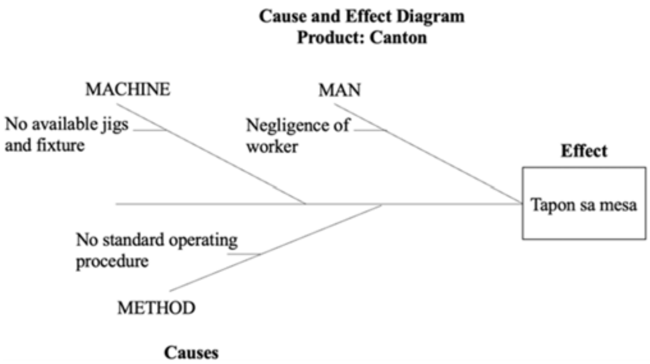

Fig. 5 Cause and effect diagram of scrap (*Tapon sa Mesa or Material spill during the operation)* wastage in canton production

Fig. 5 illustrates the causes of the “sunog” defect in canton production, categorized into Man, Machine, Material and Methods. Common issues identified include poor quality of flour, inconsistent frying temperature, lack of cycle times for frying, and operator negligence. These factors contribute significantly to the occurrence of the defect.

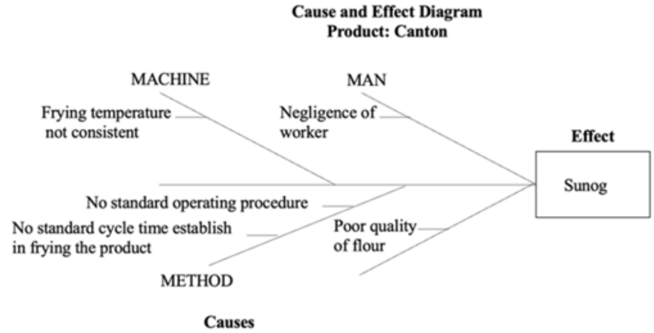

Fig. 6 Fishbone diagram of scrap (*sunog or burnt material of the product*) wastage in canton production

Fig. 6 illustrates the causes “Tapon sa Mesa” defect in canton production, categorized under Man, Machine, Material, and Methods. Key factors include the absence of established standard operating procedures, lack of available jigs and fixtures, and operator negligence.

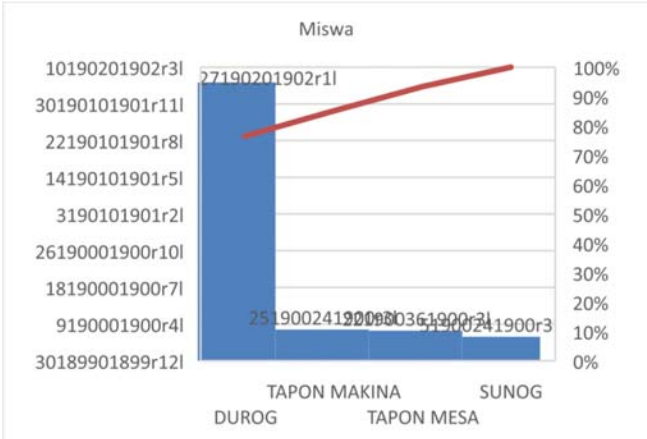

Fig. 7 Pareto diagram of scrap wastage in misua production

Fig. 7 indicates that the primary root cause of the “Tapon sa mesa” defect in canton noodles is attributed to the absence of standard operating procedures for specific processes. Additionally, the lack of training and the absence of refresher training for operators contribute to this issue.

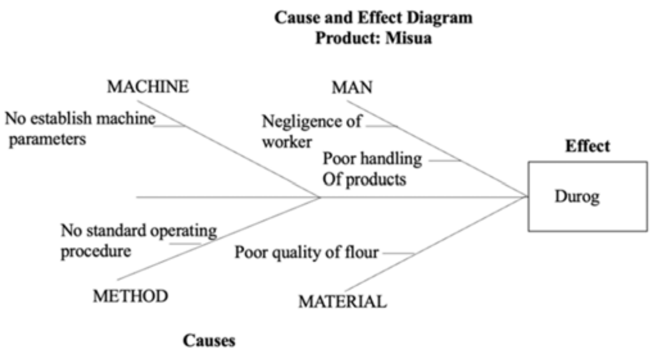

Fig. 8 Cause and effect diagram of scrap wastage in misua production (*durog or deformed powdered product)*

Fig. 8 illustrates that the "Durog" defect in misua production is influenced by factors related to Man, Machine, Material and Methods. The identified issues include poor quality of flour, the absence of established standard operating procedures, lack of machine parameters, and negligence by some operators in the proper handling of goods.

TABLE V
RELATIONSHIP BETWEEN CYCLE TIME AND WASTAGE

n	3
t	-17.4695
d.o.f	4
critical value	2.776

r = - 17.4695 which is greater than the critical value of 2.776.

If the r-value exceeds the critical value, the null hypothesis is rejected, indicating a significant relationship between the cycle time and wastage. The findings suggest that as the cycle time decreases, the wastage tends to increase [18].

The results from Table V illustrate the significant relationship of cycle time and wastage for all the noodle products — canton, miki, misua. On the average, each product yielded various amounts of wastage.

TABLE VI
RELATIONSHIP BETWEEN CYCLE TIME, PRODUCTION OUTPUT AND WASTAGE

SS	df	MS	f	P-Value	f-crit
5,754,559,074.67	2	2,877,279,537.33	112.4	0.00	5.14
153,587,83.33	6	25,597,977.22			
5,908,146,938.00	8				

The ANOVA F-critical value, denoted as F-crit, serves as a benchmark for determining the statistical significance of the F-value obtained from the analysis. In this scenario, with an F-critical value of 5.14 and an F-value of 112.4, a substantial difference is observed. The F-value greatly exceeds the critical threshold, indicating a strong likelihood that the observed differences among group means are not due to random chance.

V. SUMMARY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

A. Summary Findings

This section outlines the primary outcomes of this research, detailing key insights and results drawn from data analysis. The findings are based on the gathered data regarding the production of noodle products — miki, canton and misua — produced by Yan Hu Food Manufacturing Inc.

The research revealed the following:

1. Production output: The total production output for the three noodle products amounted to 417,990 kg. Specifically:
   - Miki: 210,412 kg,
   - Canton: 173,376 kg
   - Misua: 34,202 kg.
2. Production Process Cycle Times: Each noodle product undergoes multiple stages in the production process:
   - Miki: Eight processes are completed in 294 seconds.
   - Dried Miki: requires eight processes and takes a significantly longer time of 21,305 seconds to complete.
   - Canton: involves 10 production processes and is efficiently completed in just 493 seconds.
   - Misua: takes a total of 18,440 seconds to go through its eight production processes.
3. Average Cycle Time: The average cycle time to complete the production cycle of each product is as follows:
   - Miki: 4.90 minutes
   - Dried Miki: 355.08 minutes
   - Canton: 8.22 minutes
   - Misua: 307.33 minutes
4. Wastage Incurred per Kilogram: The quantity of wastage incurred for each noodle product during production was:
   - Miki: 1,259.41kg,
   - Canton: 2,894.41 kg
   - Misua: 991.91 kg.

B. Conclusions

The conclusions of this study provide insights into the noodle production processes at Yan Hu Food Manufacturing Inc., particularly focusing on the period from August to October 2019. Based on the research findings, and the company's operational realities, several key interpretations are drawn [19].

This study delves into the noodle production processes of miki, canton, and misua, focusing on data collected from August to October 2019. Notable findings include the highest production output observed in miki at 210,412 kg, followed by canton with 173,376 kg, and misua with 34,202 kg. The evaluation of production process cycle times revealed variations, with canton having the fastest cycle time of 8.22 minutes, miki at 4.90 minutes, and misua with the longest cycle time of 307.33 minutes, particularly for dried miki at 355.08 minutes.

Wastage analysis for each product showcased that canton experienced the highest wastage, amounting to 2,894.91 kg over the three-month period, followed by miki with 1,259.41 kg, and misua with 991.91 kg. Financial implications based on wastage costs disclosed that canton incurred the highest cost at 81,057.48 Php, contributing to a total wastage cost of 144,094.44 Php for the company.

A comprehensive cause and effect analysis pinpointed issues in Man, Machine, Methods, and Materials. Further validation through ANOVA substantiated significant differences in production outputs among canton, miki, and misua. The relationship between cycle time and wastage indicated that as cycle time decreases, wastage increases, emphasizing a substantial connection.

The study concludes with formulated recommendations aimed at addressing production wastage and enhancing productivity in the manufacturing processes of miki, canton, and misua at Yan Hu Food Manufacturing Inc. These data underscore the critical need for effective solutions to mitigate financial losses associated with wastage in the company's noodle production.

C. Recommendations

Recommendations in this section are grounded in the findings and suggest specific measures and guidelines for Yan Hu Food Manufacturing Inc. to enhance production efficiency, reduced wastage, and optimize processes.

1. *Adopt a Pull Manufacturing System:* The research recommends Yan Hu Food Manufacturing Inc. to implement a pull manufacturing system to match production outputs with customer demand. This system will help the company avoid overproduction, reduce wastage, and optimize cycle times, leading to a more efficient production process.
2. *Wastage Monitoring and Research for Reuse:* The company should establish proper machine parameters in mixing and developing standardized operating procedures to monitor the wastage for miki, canton, and misua. In addition, we suggest conducting research and development to explore the conversion of wastage into animal feed, reducing material losses and improving sustainability.
3. *Detailed Action Plan Based on Cause-Effect and Root Cause Analysis:* The following specific improvements are suggested to address issues identified in Man, Machine, Methods and Man. These improvements include the need to check and evaluate each manpower capabilities, as well as the need to establish training outline and assessment for manpower to be effective and efficient. Operator regularization may also improve quality products [20].

- *Methods:* We need to enhance the system for recording production inputs and outputs for each product in every process to eliminate inaccuracies and improve overall data integrity. This includes establishing and implementing standard operating procedures for each stage and setting standardized times for each process to ensure consistency. Additionally, we should implement a thorough monitoring system for production output and waste to maintain operational efficiency and identify areas for continuous improvement.
- *Materials:* We need to implement comprehensive testing procedures to ensure that the quality of raw materials, such as flour, meets the required standards for noodle production, and we should regularly conduct supplier evaluations to uphold these quality standards and ensure that the mixtures and consistency of input raw materials from each supplier remain consistent across all products. This proactive approach will contribute to higher quality outputs and minimize variability in the production process.
- *Machine:* Regular monitoring of machine efficiency is essential. We suggest the replacement of outdated machines and adopting new technologies to improve overall productivity. Routine machine maintenance, including daily checks, parts monitoring, and preventative maintenance, must be established to prevent breakdowns and reduce downtime.

4. *Process Improvement and Operator Training:* To boost production output and cater to more customers, process improvements are necessary. Additionally, providing regular training for the workers will enhance their efficiency and effectiveness. Yan Hu Food Manufacturing Inc. should also consider operator regularization to reduce turnover, and cut training costs, and improve product quality.
5. *Implement SMED and Combined Process:* Applying SMED (Single-Minute Exchange of Die) and combining processes can significantly improve cycle times while minimizing potential wastage. This will streamline production processes and reduce time losses in manufacturing [21].
6. *Continuous Improvement through Monitoring and Maintenance:* Establishing consistent monitoring and continuous improvement is vital. Setting machine parameters and frequency checks across all production processes will ensure stable operation. Refresher courses on Work Instruction and Standard Operation Procedures should be conducted regularly.
7. *Sustainability and Waste Repurposing:* We recommend exploring opportunities to convert noodle production waste into animal or snail feed. This not only helps reduce wastage but also supports sustainable practices.
8. *Quality Management and Statistical Process Control:* Implementing Quality Management Systems (QMS) and Total Quality Management (TQM) can prepare the company for ISO certification, improving overall production quality. Establishing a dedicated quality team focused on process improvements (QA) and product improvements (QC) will ensure consistent product standards. The application of SPC can further assist in reducing the frequency of wastage and improving production consistency.

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