ENRICHMENT PROGRAM REPORT

FINISHED GOODS PACKAGING DEFECT ANALYSIS IN PT SO GOOD FOOD

STUDY PROGRAM
Food Technology

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INTERNSHIP REPORT

FINISHED GOODS PACKAGING DEFECT ANALYSIS IN PT So Good Food

By

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ABSTRACT

The process from the packaging room to the distribution enhances handling exposures that, if ignored, will cause a certain proportion of defects and losses in appearance and performance (Tummala & Schoenherr, 2011). Besides, any error a business makes will eventually result in a cost, whether it's a lost customer, the need for rework, wasted time or resources, lost efficiency, or decreased production (George, 2010). It is stated as the current problem in the company from the data gathered from June to September 2022 the % defect is 0.78%. Since it is crucial to preserve the defect at a minimal level and even reduce it, analyzing the defect in order to see the most likely defect and know the source of the defect is essential. This project used the Six Sigma approach. Several analyses were conducted in order to perform the methodology of defining, Measuring, Analyzing, and giving solutions. Based on analysis it is mainly due to handling as the secondary packaging gets a dent, scratch, and wetted due to leaked product. Hence, this study suggested some alternatives to pallet pattern and wrapping, the addition of QC packing, and lastly increasing the height of secondary packaging to reduce pressure on the product.

Keywords: Defect, packaging, six sigma, handling, Finished Goods

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LIST OF ABBREVIATIONS

UHT - Ultra High Temperature

TPA - Tetra Prisma Aseptic®

TFA - Tetra Fino Aseptic®

EAA - Ecolean Air Aseptic®

DPU - Defect per Unit

DPO - Defect per Opportunity

DPMO - Defect per Million Opportunity

SQL - Sigma Quality Level

QC - Quality Control

RnD - Research and Development

NA - Nutrient Agar

OSA - Orange Serum Agar

CCA - Colony Count Agar

PCA - Plate Count Agar

VRBDA - Violet Red Bile Dextrose Agar

TGEA - Tryptone Glucose Extract Agar

PDA - Potato Dextrose Agar

I. INTRODUCTION

1.1. A Brief History of The Company

A multinational corporation operating under the Japfa Group's auspices, PT So Good Food engages in the Fast Moving Consumer Group (FMCG) for processed foods and beverages made from livestock products, such as the handling, processing, and distribution of chicken and dairy goods.

Initially, PT Greenfields Indonesia helped to produce UHT milk products for PT So Good Food. On September 24, 2013, PT So Good Food inaugurated its own dairy plant in Teras District, Boyolali, Central Java Province, which allowed PT So Good Food to manufacture its own products. PT So Good Food-Dairy produces its products using Ultra High Temperature (UHT) milk bearing the "REAL GOOD" brand in the shape of TFA packaging or commonly called "Susu bantal", and they also launched their newest product So Good Sterilized Milk on 24 January 2022, the UHT goods manufactured will ultimately be sold across Indonesia.

PT So Good Food - Dairy unit is only available in Boyolali. In addition to being conveniently located along the Solo-Semarang highway, Boyolali is a region known for its fresh milk production, which is used as the primary raw material to create UHT milk. The location was chosen since it is an industrial area and thus it is easy to accommodate labor. Moreover, Boyolali really does have an abundance of fresh milk raw materials, which may benefit the business with low production costs and low operating expenses.

1.2 Vision and Mission of PT So Good Food Dairy

1.2.1.Vision

Company vision of PT So Good Food is becoming a company that is committed to providing food to meet customer satisfaction, quality, safe for consumption, halal, and compliant with regulations, as well as making continuous efforts to enhance quality.

1.2.2. Mission

PT So Good Food by running a business in the field of food processing, namely the dairy industry by

1. Produce quality dairy products to meet consumers.
2. Empowering human resources for prosperity and independence.
3. To become a reliable and trusted provider of protein and nutritious food for the growth and happiness of families in Asia.

1.3 The main activity

Producing milk products from raw materials to finished goods is the primary activity of the So Good Food Dairy unit. The first product created by the PT So Good Food UHT unit in Boyolali was "regular milk", which was flavored with chocolate, strawberries, and sweet cheese. Subsequently, the PT So Good Food Dairy unit increased the variety of flavors available by introducing Real Good products with blackcurrant, guava, and orange flavors, which are more commonly known as Lactic Acid Drink (LAD) products due to the addition of citric acid and lactic acid. In January 2022, they launched their newest product, So Good sterilized milk.

Figure 1. New product of PT So Good Food - So Good Sterilized milk

PT So Good Food Dairy's main activity breaks down into 7 general steps. **First**, milk as raw material will arrive at the dairy unit of PT So Good Food and it goes into the receiving station. **Second**, the analysis of raw material before loading it into the processing plant.

Thirdly, upon analyst approval, a pipe connects the milk tanker to the processing plant. The milk then undergoes degassing and cooling prior to entering the reception tank. The milk is pasteurized and stored in the pasteurized tank before being transferred to the blending tank. In the meantime, all ingredients except colorant and flavor are mixed in the mixing tank, and then the ingredient in the mixing tank is transferred to the blending tank to be combined with milk, colorant, and flavor. The final step of processing involves exposing the product to high temperatures using the UHT method, followed by storage in an aseptic tank. **Fourth,** goes into the filling machine. PT So Good Food has two brands of filling machines: Tetra Pak® and Ecolean®. There are three types of packaging shapes and materials: Tetra Fino® Aseptic (TFA), Tetra Prisma® Aseptic (TPA), and Ecolean Air Aseptic® (EAA). **Fifth**, Products with primary packaging are placed in secondary packaging and palletized for storage. **In the sixth step,** palletized goods will be stacked in storage. **Finally**, unrack pallet so they can be loaded onto trucks for distribution.

1.4. Organizational structure

PT So Good Food Dairy unit in Boyolali is used exclusively for milk processing, the headquarters in Surakarta is distinct from the plant in Boyolali, and there is a Plant Manager who oversees every department in the Boyolali plant. Existing departments include production, Quality Assurance / Quality Control (QA/QC), maintenance, warehousing, purchasing, Production Planning Inventory Control (PPIC), department procurement, finance and accounting (FA), and HRGA (human resources and general affairs). The organizational structure of PT So Good Food Dairy is depicted in Figure 2.

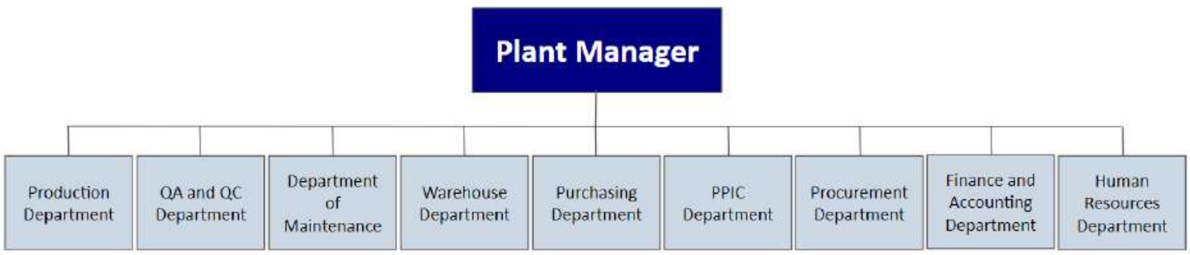

Figure 2. General Organizational structure in PT So Good Food Dairy

1.4.1 Production department

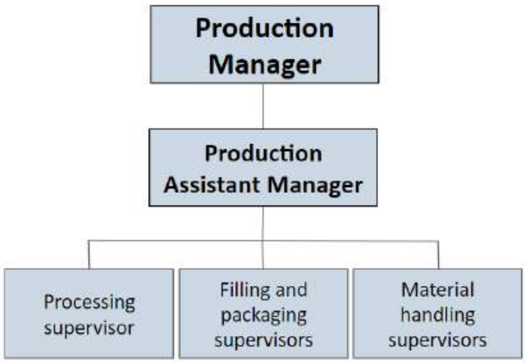

Figure 3. Production department structure in PT So Good Food Dairy

The production department is led by a production manager who is in charge of supervising and managing every stage of the production process, from receiving raw materials—particularly fresh milk—to their final process into UHT milk products. The production manager has a production assistant manager. The role of the production assistant manager is to support the production manager in carrying out their responsibilities. The production assistant manager directly supervises the processing supervisor, filling and packaging supervisors, and material handling supervisors. The production department is divided into several sections, namely the processing section, the filling section, the material handling, and the administration section. The process section consists of the reception and pasteurization of fresh milk raw material, followed by mixing and UHT.

1.4.2 QA and QC department

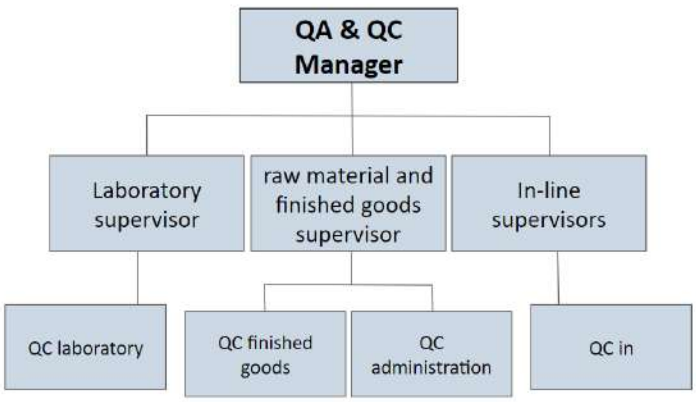

Figure 4. QA and QC department structure in PT So Good Food Dairy

The Quality Assurance/Quality Control Department is led by a QA/QC manager who oversees quality control in all production areas to ensure that high-quality, wholesome goods are produced. PT So Good Food combines QA and QC into one department. The laboratory supervisor, raw material and Finished Goods supervisor, and in-line supervisor are the three supervisors that report directly to the QA/QC manager. QC staff members assist in quality control inspection in each sector.

All analyses of production-related materials, including fresh milk, processed milk, reprocessed milk, usage of CIP solutions, and others are the responsibility of the QC laboratory. When creating UHT milk products, the entire process—from receiving fresh milk or receipt to pasteurization, mixing, and UHT processing—falls within the purview of the quality control procedure.

There are two sections of the QC lines which include QC packing and QC filling. Quality control in-line responsible for the process of filling or inserting UHT milk products into packs and checking those goods that have entered the pack, been placed into corrugated fibreboards, and been arranged on pallets are secure and ready for distribution. Additionally, the processing of reprocessed products is done while also taking precautions to prevent cross-contamination in the filling area. Prior to filling, the Clean In Place (CIP) procedure is also supervised by in-line quality control.

QC finish good is responsible for the UHT milk incubation process, ensuring that the product is prepared for distribution. The truck that will transport the product and those transporting raw materials and packaging materials are all inspected by QC finish goods. It is the responsibility of QC raw materials and packaging materials to store raw materials such as components for skim milk powder, chocolate powder, refined sugar, and other goods, as well as the packs used for UHT milk products.

Controlling the documents used for quality control during manufacturing up until the product is released is the responsibility of administrative QA/QC. The quality assurance team and document control also guarantee that all documents are properly recorded and saved. Additionally, QA personnel and document control help the supervisor in audit operations, prepare Halal MUI and BPOM-related documents and ensure that Good Manufacturing Practice (GMP), Hazard Analysis Critical Control Point (HACCP), and ISO are carried out in accordance with guidelines.

1.4.3 Department of maintenance

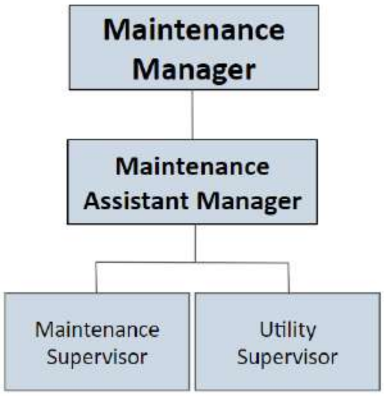

Figure 5. Maintenance department structure in PT So Good Food Dairy

The maintenance manager, who oversees all of the production process support equipment including care, maintenance, spare parts, and in case of damage, as well as utilities for water, power, and fuel, is supported by the maintenance assistant manager. The utility supervisor and the maintenance supervisor are the two supervisors under the control of the maintenance assistant manager.

1.4.4 Warehouse department

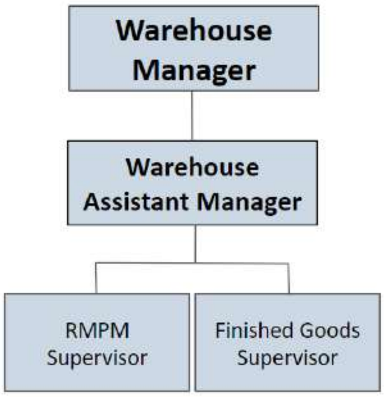

Figure 6. Warehouse department structure in PT So Good Food Dairy

The warehouse manager, who is supported by the warehouse assistant manager, is in charge of the warehouse or warehousing department. The assistant manager directly supervises the RMPM supervisor and Finished Goods supervisor. The Finish Goods supervisor is in charge of everything in the warehouse, including product storage, raw material, and pack material storage, managing the release of distributed products, and managing the use of raw materials and packaging materials. The raw material pack material (RM/PM) division and QC completely well cooperate with the warehousing department.

1.4.5 Purchasing department

A purchasing manager oversees the department, with assistance from a purchasing assistant manager. For the process to take place, they are in charge of providing raw materials, packaging materials, chemicals, and technical support. The purchasing department is in charge of and authorized to choose the equipment, supplies, and services that the business will utilize by assessing several vendors.

1.4.6 Production Planning Inventory Control (PPIC) department

The Production Planning Inventory Control (PPIC) Department is led by the PPIC Supervisor, who is in charge of monthly production planning based on marketing data. The supply of raw materials for production is another task assigned to the PPIC Department. Every three months, marketing reviews a record of product requests to determine the production schedule.

1.4.7 Procurement department

The procurement supervisor, who controls the procurement department, is in charge of providing the primary raw materials—fresh milk and other primary additives like skimmed powder—needed for the manufacturing process.

1.4.8 Finance and accounting department

The FA manager, who is in charge of the finances and corporate bookkeeping for all departments, serves as the chair of the finance and accounting (FA) department. The FA supervisor supports the FA manager in their duties.

1.4.9 Human Resources department

The HR manager, who also serves as the department's chair, is in charge of two supervisors, known as the Human Resources and General Affairs (HRGA) supervisors, who are in charge of the department's employment and general operations, including workforce planning and selection, development, and evaluation. K3 Supervisor who is in charge of trash disposal, environmental management, and worker safety.

1.5. QC and production department of PT So Good Food

The interns work and learn under the QC and Production department of PT So Good Food. QC department provides knowledge, lab work, and experiences to maintain milk products' quality and solve problems throughout the production process. While Production department give more knowledge about processing step, the function of each step and how to conduct Cleaning in Place (CIP)

Under this division, the intern works in production plant to gain knowledge of milk processing and CIP step, learn the microbial analysis process, and Finished Goods to analyze defective packaging observed in Finished Goods, by using the Six sigma approach to reduce defects, reduce cost and increase labor productivity. It involves defining the problem, measuring the problem, analyzing root cause, and giving applicable solutions.

II. INTERNSHIP ACTIVITIES

2.1 Internship Working Conditions

The working environment at PT So Good Food was fun but also quite challenging. For the welfare facilities, there are adequate toilets and also many sinks were provided to keep the worker's hygiene, there are lockers for the staff to put their stuffs. Several facilities such as a prayer room, a place for having conversations during break time, and a spacious parking lot are also available. Every staff in the plant production until the loading station needs different personal protective equipment. Lab coats are provided to give skin protection as well as personal clothing from accidental contact or small splashes. The lab coat used by the QC production, QC, line, and analysts is important to prevent the contaminants from spreading outside the lab. The lab coats are borrowed from the company for the staff. If it is dirty, they can put it in the laundry basket and ask for a clean lab coat. There are boots available to protect feet and legs from water and chemical spillage that are commonly used if staff want to go to the plant production and filling room. Besides protecting the foot from chemicals it is also beneficial to prevent dirt from outside from entering the filling room, as the filling room should be aseptic (without contamination). Gloves are provided by the company as protection against chemical agents and microbial infection which are usually used by the analysts when conducting microbial analysis and QC packaging while conducting packaging integrity check since it used chemical agents. Protective helmet is used to protect the head from the impact of falling objects. This helmet is used in a storage room.

Every room in PT So Good Food is very clean since they hire adequate OBs (office boys) to clean each department every day. The lights are also adequate for the staff to do their job optimally. Ventilation was somewhat lacking due to the plant production and lab filling room being an aseptic area, therefore, there is minimum ventilation but the air circulation was quite good. The temperature while working in the processing plant tends to be hot because in processing there is a cooking process that makes the temperature rise. It should be cold in the lab room, but because the air conditioner was broken the room has become stuffy and the air circulation was not good enough making the employees drowsy, in the filing room it tends to be cold because the place is aseptic, in the packing room and in the storage room the temperature is normal there is no air conditioner, but the air ventilation is sufficient.

In the lab, the working conditions are good. However, the temperature should be slightly cold, but the air conditioner has broken several times, so the room became quite hot and made the staff less focused and sleepy. It might have happened due to the less O2 in the atmosphere. In the production plant, the working condition was slightly hot and noisy from the machine, workers need to be careful when the Cleaning in place (CIP) process runs because there is chemical evaporation during this process, as it may cause itching. The filling room is the cleanest, cold, and very aseptic room in PT So Good Food since this is the place where the product is placed in primary packaging aseptically.

Workmate in PT. So Good Food is very kind and helpful. They give a chance for the intern to experience what they did. They willingly teach the intern to conduct things and also give knowledge based on their experience in the field. The supervisor was also very kind and willing to make time for interns for meeting arrangements twice a week to update progress, projects, and problems during their internship at PT So Good Food and also assist intern students well and also be very insightful.

The working schedule was typically irregular as it did not depend on the normal working hours but depends on the task conducted by the intern. Sometimes the task didn't require interns to do tasks onsite, and sometimes the intern had to come early, stay late, or work during the weekend/holiday. For the first 6 weeks, the intern was most likely to work offline, in the lab, processing plant, filling room, packaging room, and finished good, however, the rest of internship weeks were mostly conducted offline in the loading station and when the intern need to trace back process for the root analysis purposes they will conduct it in the storage, packaging room, filling room and even in the lab to conduct the packaging analysis. In the remaining time, the intern conducts the analysis remotely to make conductive working conditions in their own space.

2.2 Internship task and experience

The intern was placed in the QC and production department in PT So Good Food Dairy Unit started on 4th July 2022. The intern was assigned to work based on the Term of Internship that has been made together with the field supervisor and internship advisor. Nonetheless, the task is adaptable to the main project (term of internship attached in 1. appendix). The activities will be explained further as followed:

2.2.1 Field observation (4 July- 16 July 2022)

For the first 2 weeks, the intern student was introduced to the plant production until finished goods department to understand the basic principle and brief activity of all departments starting from raw materials until finished goods as well as quality control. The intern started to familiarize themself with the company, by observing the process of receiving fresh milk and analyzing milk with the assistance of the analyzing staff. After that, the intern began to understand the processing plant in PT So good food by having a direct look at the processing plant production process with the assistance of the production supervisor in order to gain knowledge about the actual milk plant production. After gaining knowledge of the milk processing plant, the intern student continued to the filing room to observe the mechanism of the aseptically packed product in the factory. PT So Good Food has 2 different packaging brands there are Tetra pak® and Ecolean®. By having different brand interns gain more knowledge regarding the mechanism of the packaging machine and packaging material in each packaging brand. In the packing room, the intern was able to look at the process of packing, palletizing, and wrapping. The intern was even allowed to try manual packing in PT So Good Food. In Finished good, interns are able to look at the racking process and be informed about the racking system in PT So Good Food. The intern was also allowed to go to the water treatment at PT So Good Food where was assisted by the utility staff to look at the water treatment process and the flow of water in PT So Good Food including the filtration process, water chiller process, and water boiler process.

After that the intern followed QC activity, there were some QC with different inspection points. There was QC production, QC line, and QC finished goods. QC production ensured every step that was a critical point in the processing plant was checked. The QC production took samples at each critical point and checked PH, color, appearance, odor, and taste to ensure it was in line with the standard before going to the next step. QC line had a job to check packaging in the filing room and take samples for analysis in the packaging room, after the sample was collected they put it in the lab or in the incubation room. QC finished goods were responsible to check packaging material and raw materials other than milk, taking the sample in the incubation room to be sent to the lab for analysis, and for QC finished goods checking PH, also had the job to conduct sampling for every pallet before being loaded.

In the lab, besides helping analysts to check milk raw material, the intern also helped the analyst streak plates for microbial analysis, check microbial growth, do plate count, do gram staining if necessary, and conduct a destroying process. Destroying process used to destroy microbes and agar in the reusable glass petri dish by high temperature and pressure is conducted by using a retort machine. The intern also got chance to follow monthly swab test, this swab test was conducted routinely every month yet divided into 4 weeks the analyst conduct the swab test on every machine in plant production, water treatment, and filling machine then conduct the microbes analysis, also the analyst done swab test for staff hand to check their hygiene. Analyze also conducted an environment test by placing agar plate in the open space for 15 minutes, however, the intern did not get the chance to follow this process due to following another staff activity.

2.2.2 Microbial Recontamination Project (18 July- 30 July 2022)

The intern was allowed to conduct microbial recontamination by the field supervisor. In a 2 weeks period, interns should understand the difference between microbial testing for septic and aseptic products and should be able to conduct microbial analysis. The microbial analysis was done by collecting the sample and then exposing it to the open air, after several hours the milk sample was analyzed according to company procedures. There are 7 agar types, which are nutrient agar (NA), orange serum agar (OSA), plate count agar (PCA), colony count agar (CCA), potato dextrose agar (PDA), tryptone glucose extract agar (TGEA), and violet red bile dextrose agar (VRBDA). NA is agar for growing non-fastidious microorganisms. NA was used when analyzing almost all samples. To grow microbes in NA it took 2 days at 35 °C. OSA is agar for growing acidic microbes. OSA was used for analyzing PT So Good Food's products that contain acid and also used for further identification in special cases. To grow microbes in OSA it took 4 days at 28 °C. PCA is an agar used for total plate count enumeration. Always be used when analyzing samples in every batch production. To grow microbes in PCA it took 2 days at 35 °C. CCA is agar for enumerating *E coli* coliform. CCA is used when analyzing almost all samples just like PCA but it is more specific to *E coli*. Microbes will grow in CCA agar in 2 days at 35 ℃. PDA agar is used to analyze air sampling in order to check the hygiene of the lab environment. To grow microbes in PDA it took 7 days at 28 ℃. TGEA is an agar used to analyze spores that are often found in unhygienic cow and cow milking areas. To grow microbes in TGEA it took 7 days at 28 °C. VRBD is usually done to assess *Enterobacteriaceae* in the product, especially when there is unsterile product found seeing by the bloated packaging, the possibility of coming from *Enterobacteriaceae* which is a gas-producing bacteria. To grow microbes in VRBDA it took 2 days at 35 °C.

In this project NA, PCA, CCA, VRBDA, and OSA agar were used to grow microbes. Microbes that grow on NA were inoculated to several object glass to conduct oxidase test, catalase test, KOH, and gram stain. An oxidase test was used to check if the microbes were oxidase positive or negative. A Catalase test was used to check if the microbes were catalase positive or negative. KOH test was used to check if the bacteria were gram-negative, since potassium hydroxide dissolved peptidoglycan layer in gram-negative, thus the cell lysis and released bacterial content including the DNA causing it to be sticky. Lastly, gram stains, besides being used to check whether the bacteria were gram-positive or negative it also shows the appearance of bacteria under the microscope.

2.2.3 Processing in detail (1 August- 6 August 2022)

In this activity the interns were having a little tour of every processing machine with more detailed observation including the function and parameters, however in this section parameters and detailed information were not discussed due to confidentiality. The tour begins with the milk receiving station where there are 2 filters to remove dirt, then the milk goes to the degassing tank to remove gas in order to get an accurate total inlet milk measurement in the flow meter. Lastly, it goes to the reception tank where the fresh milk is being stored. There are 2 receiving tanks and the capacity of each tank is 30.000 liters. The milk from the receiving tank was then transferred into the pasteurizer to kill bacteria and therefore increased milk shelf life. The pasteurized milk then passes a plate heat exchanger to cool down the milk before being stored in a pasteurized tank. Next is the mixing tank, the function is to mix ingredients with hot water by incorporating all ingredients in a hopper, then begin to circulate back and forth from the hopper to the tank until the ingredients are mixed well. There are 3 mixing tanks and 1 cocoa tank. The cocoa tank has the same purpose as the mixing tank but it is only used for cocoa flavor. There is also a blending tank, which is used for combining pasteurized, mixture from mixing tank, coloring, and flavoring constantly by agitator. There are 4 blending tanks with a capacity of 20,000 L for each tank. In the blending tank the product cooled down by 4℃ and to keep the blending tank temperature “Double water jacket” mechanism was applied to prevent surrounding air from causing the temperature change.

There is a balance tank to keep the volume before entering UHT to maintain product flow in the UHT machine. There is also a deaerator to remove air bubbles in the product. The mechanism of deaerator is when the temperature is low, O2 solubility increases, and therefore increasing temperature would help to reduce solubility of O2 causing the O2 to be released from the product. There is also a homogenizer to reduce the size of fat globules, increase the surface area and make it stable and uniform. This is the main process in the production plant is UHT to reduce bacteria and increase shelf life of products. After that Pre-cooling process where the product cooled down to 80-60 ℃, and further cooling process to 18-25℃, lastly before going to filling the product stored in an aseptic tank at 18-25℃.

2.2.4 Cleaning in place in detail (8 August- 13 August 2022)

The interns should be able to understand the details of cleaning in place (CIP) for 1 week. The CIP process for the inner part of the tank operates automatically by having a spray ball in every tank and manually for the outer part of the tank. The intern went to the control room since the main CIP process performs in the control room. There are 2 CIP stations, one for non-aseptic machines and the second one for aseptic machines.

To conduct the CIP process first, **check the condition**. Things that are important to be checked include the pressure of the targeted tank, whether the targeted tank should be checked if it is already empty or not, and whether or not the connection from the CIP tank to the targeted tank is already installed properly. The next step is to **select the CIP mode.** There are 5 modes which include sterilization (Hot water), caustic, acid, acid & caustic, and flush (Water with normal temperature).

In the processing plant, there are 2 CIP processes which are final and intermediate. Intermediate CIP is used for cleaning UHT machine when the production process runs but the aseptic tank is full, intermediate cleaning is also conducted when the sensor before and after holding tube in UHT detects increased temperature by 10℃ since high temperature can make the product burn, thicken, and turn into a crust on the pipe. This process uses caustic CIP mode, to wash off fat remaining in the pipe and to reduce cost. After a production process finished the final CIP was conducted in every tank by using acid & caustic CIP mode.

When CIP mode has been determined, the next step is to **pre-rinse** for a non-aseptic machine. The pre-rinse process was done by using hot water while the aseptic area, it was using room temperature water. After that, **fill the caustic to the tank**, then **empty tank**, **fill caustic to CT** meter, then conduct **caustic circulation**, fill water to tank, then **empty tank, purge acid or caustic to CT** meter, then continue with acid if conducted final CIP. The last step is to flush it with hot water.

2.2.5 Packaging defect analysis in finished goods - Main Project (15 August- 30 October 2022)

The packaging defect analysis project is started by the third-month of the internship. This project was assigned by the field supervisor to know the defects that mostly occur in Finished goods and the root cause, also to reduce the occurrence of defects in the finished goods department. This project was conducted by gathering data for one month and then conducting define the problem and setting goals, measuring current baseline, an analysis, testing, and giving solutions. The interns completed the analysis for the defect analysis project in the final month of the internship. This packaging defect analysis project will be further discussed in the next chapter.

Besides doing the internship project, the intern students were also helping the company to conduct their daily activities with their assistance and supervision, for example, conducting milk raw material analysis, doing the sampling in the packing room, analyzing the sample in the microbiology lab by streak plating sample, and PH check. Summary of the internship work and timeline has been described in Appendix 2. Due to the time limitation of the internship period, some activities have been diminished. Therefore, only 5 activities were performed in this project. The intern did a final presentation in PT So Good Food on the last day of the internship as a way of taking responsibility for what has been gained from the internship as well as the outcomes of the projects that have been studied.

2.3 Comparison between theory and practice

Through this internship, the intern gained more knowledge and experience in the milk and dairy sector. By doing field observation, the intern got a broad idea about factory design, since that course was not covered in I3L, also the intern got the idea of plant layout in the factory. The intern has learned how to conduct microbial analysis in i3l through microbiology, food microbiology, and microbiology lab, therefore the intern takes the chance that field supervisor gives to do microbial recontamination, by having knowledge the intern can follow the company procedure in doing microbial analysis easily. When learning the processing in detail, actually it is mostly covered in the milk and dairy course, but through this internship, the intern can see the whole milk and dairy process in the field and see how to conduct the processing step and record parameters to be checked in the plant. For CIP in detail, the intern got the theory from the food engineering course and through the internship, the intern gained understanding of how to conduct CIP in the factory in more detail and get the idea of the CIP process in the plant.

The main project of the internship focused on packaging defect analysis of Finished Goods as one of the fields in Food Technology study, with Fundamentals of Food Packaging course that gives the intern the basic knowledge of food packaging function and material. In the field there is 2 packaging brand used by the company the Tetra pak® and Ecolean®, intern get the access to packaging guide book, therefore, the intern can study the packaging layer the mechanism of sealing the packaging, and test packaging integrity in the lab, the intern also got field trip for the packaging room assisted by packaging room supervisor and specific on how to conduct packaging integrity the intern learned from QC line that showed their daily activity to check packaging integrity. Besides that total quality management course also has benefits, this course gives the introduction to Six sigma briefly, the rest of how to conduct six sigma, the methodology, and the supporting tools for analysis done independently by the intern. This internship allowed students to explore, observe, and analyze in order to learn the Six sigma analysis. The intern learned how to collect data and analyze samples by hand and in the lab, including tracing back to analyze the problem, determining the most likely concern, and observing product transfer process in the field.

Through theory and field experience, as well as the application of this knowledge, the intern develops knowledge in a variety of areas of food technology. Through this internship, the intern gained experience in critical thinking to solve the company's problems by analyzing the root cause of the problem and proposing solutions to the problems faced by the company. The intern also learned how to comprehend the demands of the organization, which necessitate communication, decision-making, and consideration of numerous factors, such as time, cost, and suitability, among others, in order to apply the knowledge that has been acquired. These practical considerations are crucial for jobs like conducting research for a business. With the guidance of this internship, additional skills are acquired, including social skills, problem-solving, self-learning, and resolving issues.

2.4 Challenge during internship

Since this was the first time for the authors to do the internship, adapting to a new working environment is quite challenging. In the beginning, it was quite hard to follow and understand the project. However, the guidance of the field supervisor that has a lot of experience in handling intern students was very helpful for the author to fit into the project and finish it. For internship activity, the author did not have any difficulty since the workers in every department were very supportive and open to share their knowledge and experience in the field.

The intern has encountered the greatest difficulty when conducting the main project, as the project relates to quality management, with the goal of reducing defects and increasing the quality of the process. The topic that was unfamiliar to the intern it was the six sigma methodology, as it has only been covered in a basic total quality management. As it has not been taught more deeply for the intern to understand a way to conduct six sigma, especially for the methodology, and the supporting tools for analysis, therefore, the intern take the initiative to watch an explanation video about six sigma, find books about six sigma, and find more journals about the project that used six sigma for a better understanding of this six sigma method. Due to all of these difficulties experienced by the author, the estimated time required to complete this project was delayed as it required more research. Thus, affecting the duration of the internship. In the future, this limitation could be anticipated by working more carefully to reduce the possibility of having to retake the analysis's processes. Also considering the time available and with company consent, limit the scope of work by eliminating some steps in the method. Furthermore, adaptive learning and problem-solving skills could be applied to improve the failed executed methods, which were later could be used to improve the result.

Outside the main project, the intern also encounters several challenges, such as when doing further observation in order to discover the root cause of a defective product, there are internal issues that result in a halt in product distribution. Consequently, observed defective product ceases to exist due to this issue. This problem is addressed by incorporating supporting data from initial observation into further observation. Lastly, due to the obtained defect product observed in Finished Goods already exposed to several handling and treatment, the results of the observation depend on the visual observation, further defect analysis if possible followed by a probable reason. Therefore, the author often debriefs with the expert in the company to support the current baseline and prevent misconceptions.

III. PROJECT DESCRIPTION

3.1. Introduction

3.1.1. Background

Due to high competition in recent years, the industry tends to compete in order to increase productivity, improve quality, and minimize product defects and waste (Prakash & Roy, 2016). In these circumstances, an effective quality control system is required to check the results of each production step to guarantee the finished product meets the intended quality standards. Any error a business makes will eventually result in a cost, whether it's a lost customer, the need for rework, wasted time or resources, lost efficiency, or decreased production (George, 2010). Many companies may lose between 25 and 40% of their revenue as a result of waste defects and errors (Arthur, 2016). Businesses tend to become more disorganized as they grow as a result of impediments in business processes, technologies, systems, and procedures, work piles up in one area of the company (Härenstam, 2005). The unifying argument in all of these situations is that the product was not created as expected due to failure to take reasonable care (Duncan & Goldberg, 2020).

In this project, interns deal with defects in the packaging. Therefore, it is necessary to understand PT So Good Food's general product transfer procedure. Following the manufacturing process, the product is immediately sent to a filling machine to be packed into primary packaging, and then it is placed on a conveyor to be manually packaged into secondary packaging at PT So Good Food. The secondary packaging is then manually palletized and wrapped prior to being transferred to storage and loaded onto a truck for distribution. The process from the packaging room to the distribution got several handling exposures that, if ignored, will cause a certain proportion of defects and losses in appearance and performance (Tummala & Schoenherr, 2011). As it is crucial to preserve the defect at a minimal level and even reduce it, therefore analyzing the defect in order to see the most likely defect and know the source of the defect is essential. The Root Cause Analysis is utilized by observing defects in the Finished Goods and tracing them back to the storage and packaging room to determine which factors and areas are responsible for the defect (Andersen & Fagerhaug, 2006). And lastly, a solution can be made to reduce the occurrence of defects.

3.1.2. Objective

- To identify the most likely packaging defect on Finished Goods.
- To analyze the root cause of the defect
- To give applicable solutions to minimize the packaging defects.

3.1.3. Scope of work

The intern main project focus on analyzing packaging defects in Finished Goods:

- Literature study in the selection of a suitable method to identify and analyze the most likely defect to occur in Finished Goods.
- Gathering defect data in Finished Goods.
- Observing activity in the packaging room, storage, and loading for the distribution process.
- Observing manpower in handling products.
- Observing the palletizing method.
- Observing wrapping method.
- Literature study in palletizing and wrapping method and optimization.
- Propose an alternative palletizing and wrapping method to increase efficiency and reduce possible defects.
- Analysis of packaging defects visually or by packaging integrity test in the lab.

3.1.4. Problem Formulation

The company wanted to suppress the occurrence of a defect by noticing the most likely defect and sources of the defect in the Finished Goods. By knowing the sources of defects the company can constantly improve those areas to minimize defects. In addition to analyzing the defect, it is essential to trace back to the packaging room to observe the method of palletizing and handling, or to the filling room to determine if there is a potential defect related to the filling machine or packaging material. Therefore in this project, it is important to analyze the data and sample gathered to explore the sources of the problem and give applicable solutions.

The project was conducted by considering topics that need to be studied and analyzed: 1) Selection of the method for process improvement 2) Method selection for packaging integrity

1) Selection of method for process improvement

The aim is to reduce defects in the company by finding the best method that is able to lead the process of the analysis. The flow will be process-oriented to ensure impeccable performance and that nothing was overlooked during the process. Additionally, supporting techniques such as Pareto charts and flow diagrams may be employed. Moreover, root cause analysis plays an important role in this study. In order to pinpoint problems, identify causes of defects, and aid in providing solutions, the root of the issue must first be addressed. Fishbone diagrams are a critical tool that has been widely used for quality control in many industries to find the root cause of a problem, and 5 Whys analysis can be used to supplement and enhance them (Kenett, 2008).

2) Method selection for packaging integrity

Understanding whether the packaging contains specific materials or layers that make defects possible under specific conditions is essential for analyzing defects, whether they are caused by internal or external factors. This knowledge allows for the most accurate and minimizing failure to describe the defects. Initially, any defects in the Finished Goods will be identified using either a visual inspection or a laboratory test for package integrity.

3.1.5. Experimental methodology

Research methodology describes the methods and approaches used to carry out this study. The processes are generally presented as follows:

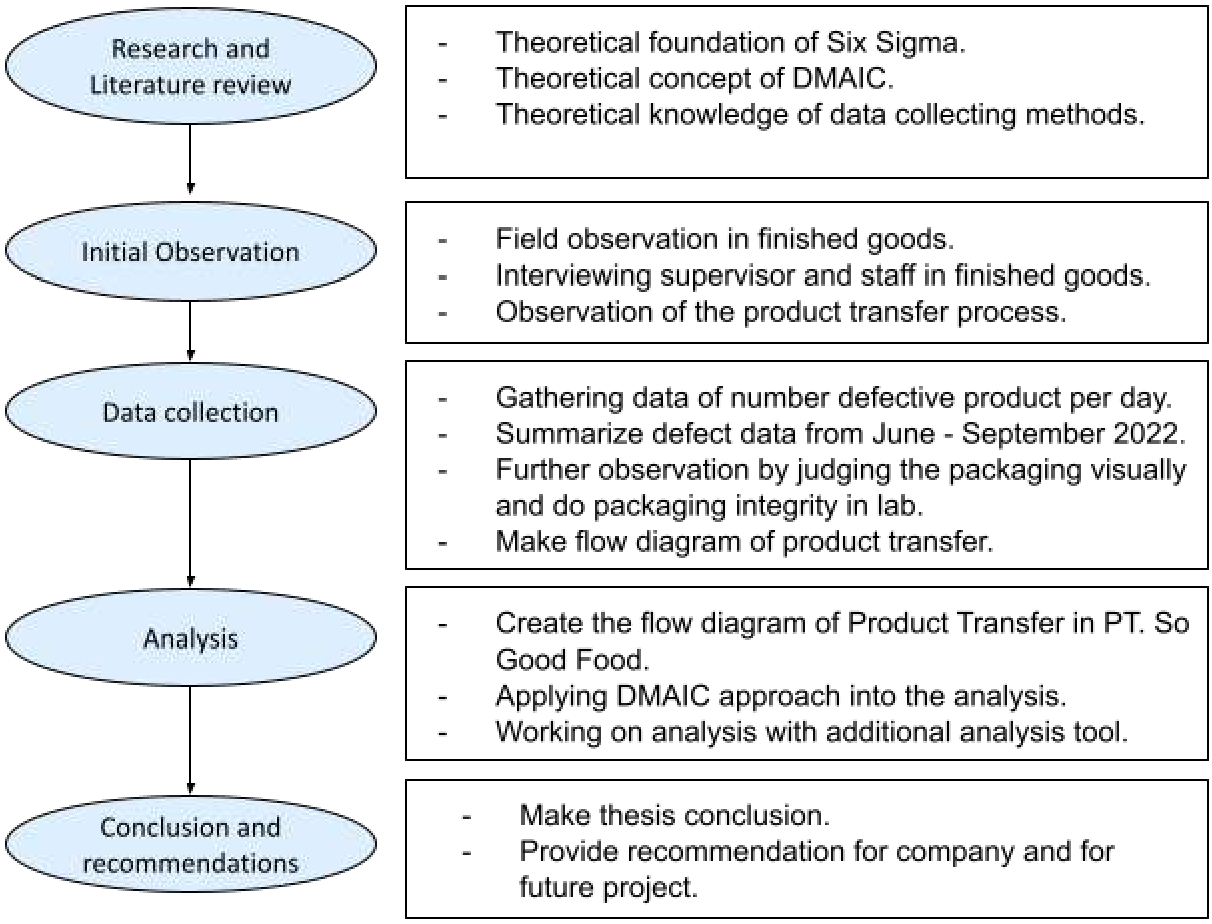

Figure 7. Research framework

3.1.5.1 Research and literature review

1) Six Sigma

The analysis used in this project is six sigma, it is a set of tools and techniques for process improvement (Montgomery & Woodall, 2008). Introduced by engineer Bill Smith at Motorola in 1980 (Dedhia, 2005). The objective of employing six sigma is to reduce the variations within a process so that the outcomes of the process can satisfy or even exceed the expectation of customers (Montgomery & Woodall, 2008).

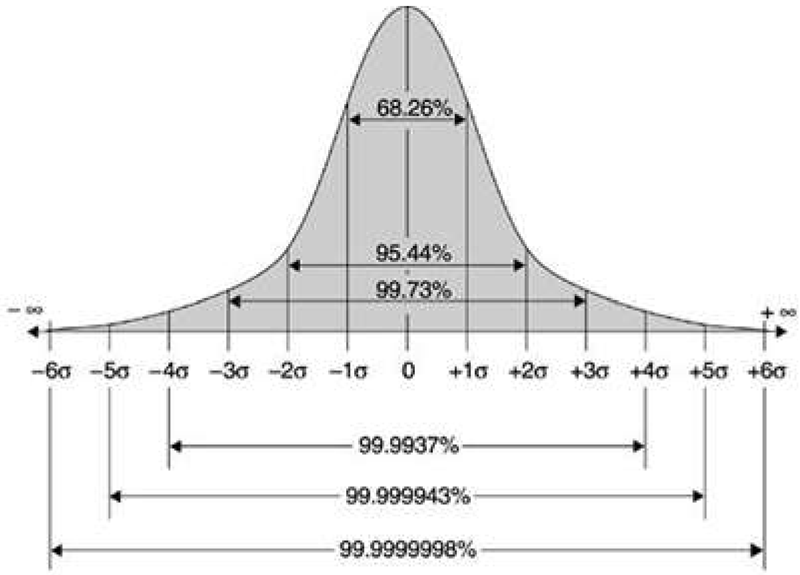

Figure 8. Six Sigma curve
http://www.louisvillelectures.org/the-ll-blog-1/sixsigma-phillips

The sigma (σ) in statistics means standard deviation. Based on figure 8, the sigma six curve represents the distribution of data and has a bell-shaped normal distribution. The curve explained that 1 sigma is represented by standard deviation in the bell curve (Raisinghani et al, 2005). The standard deviation is utilized to measure the distance of the data from the mean. In any distribution of this type, one sigma above and below the mean encompasses 68% of the data. The goal of having six sigma is to achieve sigma six, based on figure 8 which has a yield of 99.9999998%, however, that yield is a short term yield. According to Hahn, Doganaksoy, & Hoerl, 2000, the standard deviation is greater when measured in the short-term yield. That happened due to the short-term process only having common cause variation, therefore 1.5 σ shift must be accounted in order to accommodate process shift from time to time as the long-term process has common cause variation and special cause variation. 1.5 σ shift gathered from the difference between common cause variation and special cause variation (Hahn, Doganaksoy, & Hoerl, 2000).

Table 1. Sigma Level

Sigma (σ)	Short-term Yield	Long-term Yield (1.5 σ SHIFT)	DPMO (1.5 σ SHIFT)
1	68.28%	30.85%	691462
2	95.44%	69.15%	308538
3	99.73%	93.32%	66807
4	99.997%	99.38%	6210
5	99.99994%	99.98%	233
6	**99.9999998%**	**99.99966%**	**3.4**

The results of increasing the sigma level of sigma six by 1,5 σ will be 99.99966% which Has defect per million opportunity (DPMO) 3.4, meaning in every 1000000 products only 3.4 defects found.

2) DMAIC methodology
The six sigma commonly complies with DMAIC methodology to conduct the analysis, DMAIC stands for Define, Measure, Analyze, Improve and control. In this project Due to time limitation, the methodology adjusted to be Define, Measure, Analyze, and giving solutions.

Define step's objective is to define the business problem, objective, potential resources, project scope, and high-level project schedule. The goal of Six Sigma is to find solutions to issues that have an impact on business performance. Prior to solving a problem or enhancing performance, a goal or objective must be clearly defined. The success of an organization depends on framing problems correctly, as defining a project is only half the improvement process. Six Sigma projects must be built in order to solve the problems that are identified during the Define stage of the breakthrough strategy (DMAIC). Recognizing weak points in the company's operations is necessary for defining projects that will succeed, and this will help to clarify the best course of action for addressing those weak points.

Measure phase establishes current baselines objectively as the foundation for improvement. Measurements include defect per unit (DPU), defect per opportunity (DPO), defect per million opportunities (DPMO), yield percentage, and sigma quality level (SQL). This step involves collecting data to establish baselines for process performance. The performance metric baseline(s) from the Measure phase will then be compared to the performance metric at the the end of control phase within a certain time to check whether significant improvement has been made. However this research is only conducted until the giving solution. Therefore, this current baseline can be used to see current performance of the company and for future projects to prove if this project has increased the sigma level in the company.

The **analysis phase** was carried out to determine, validate, and select the root cause of the problem. The intern will then be helped to identify the problem's root cause by being able to see the problems' causes and the results of those causes during this phase.

To find, recognize, test, and solve the problem, the **Giving solution phase** is conducted. This phase's objective is to find, identify, and test a solution and put an end to the problem, in part or in its entirety. The solution to the problem is entirely dependent on the circumstances. The main idea of the Improve phase is to identify inventive methods for eradicating the most important root causes so that the process problems can be fixed or avoided.

3) Data collecting method

Several tools are required to aid in each phase of the analysis. In the preliminary analysis conducted during the defined phase, flow diagrams and Pareto charts were utilized. The flow diagram is a visualization of a sequence of actions, movements within a system, and/or decision points (Li & Chen, 2009). They are a comprehensive explanation of each step in a procedure, regardless of its complexity. It displays the product transfer process from the package of the material until the loading process to assess the handling exposure during product transfer. Pareto chart was used to point out the most likely defect occurring in finished goods to be analyzed further (Harvey & Sotardi, 2018). The objective is to clearly see the factors that have the greatest impact. Benefit, Save time, effort, and money in fixing problems by having 20/80 rules (Harvey & Sotardi, 2018). Applying 20/80 rules means solving 20% of the types of defects can eliminate 80% of process failures.

Several calculations and data are collected from the finished goods department in order to measure the current baseline. In **measure phase** it measured current baseline. There are several calculations and data gathered from the finished goods department. The measurement not coming from the higher defect percentage as by this measure phase, it reveals the current sigma level in the process.

Defect per Unit (DPU) measures the average number of defects found on a single unit (Antony & Coronado, 2002). In Six Sigma, the thing being worked on is referred to as a unit. Measuring the total number of defects over a known number of units is a fundamental method for evaluating the capability of a characteristic or a process (Mehrjerdi, 2011).

Defect per Opportunity (DPO) estimates the number of faults that occur per success or failure opportunity (Antony & Coronado, 2002). DPO permits a realistic comparison of the defect rates of products with vastly differing levels of complexity (Mehrjerdi, 2011). The number of inherent opportunities within a unit, regardless of that unit's nature, is a clear indicator of its complexity. To determine the complexity of a unit, one must count or estimate the number of options for success or failure (Mehrjerdi, 2011). Occasionally, opportunities are individual traits that are crucial to the performance of the system. Other possibilities are characterized by a specification. With a determined DPO measurement, you can now compare for example the capability of a car to that of a bicycle in a fair manner.

When the number of opportunities on a unit is high and the number of reported defects is low, the estimated DPO measurements become so small that they are difficult to work with. Defect per Million Opportunities (DPMO) is the average number of defects discovered for every one million opportunities (Antony & Coronado, 2002). It is most effective when the process or trait is repeated countless times. Counting the number of defects across a bigger number of opportunities is a straightforward solution to both of these problems. This defect rate statistic is referred to as defects per million opportunities (DPMO) in Six Sigma and is utilized frequently (Mehrjerdi, 2011).

Sigma Quality Level (SQL) considers the quantitative metrics of the process's quality and capabilities (Antony & Coronado, 2002). The definition of Six Sigma is 3.4 faults per million opportunities. This is referred to as a Six Sigma quality level. A sigma score essentially indicates the number of standard deviations that can fit between the mean and specification limit of any process or specification (Mehrjerdi, 2011). The sigma score can be used to evaluate the performance of anything with a specification and failure rate. All sigma scores can be compared directly to determine the capability of a process or attribute (Antony & Coronado, 2002).

In the analyze phase the root cause of the analysis is determined by fishbone diagram and whys analysis. The root cause gives the general idea about the factor and problem that leads to defect. A fishbone diagram, so-called because of its skeletal, fish-like appearance, is one of the simplest yet most effective brainstorming tools for identifying all the potential system elements. A fishbone diagram is sometimes referred to as an Ishikawa diagram, after Kaoru Ishikawa, who initially proposed its use. Fishbone diagram contains vital information. A correctly completed fishbone diagram serves as the basis for the analysis phase of the DMAIC project road map since it collects a vast number of potential inputs (Ilie & Ciocoiu, 2010). However, an inadequate fishbone diagram makes the remaining half of the progress more difficult (Cox & Sandberg, 2018). A fishbone diagram is so straightforward and created by placing the project's Y, its primary output, at the head of the fish. Then, to stimulate your creativity, design a backbone with six major bones extending to the sides. These bones reflect the primary groups of factors captured: man, machine, method, measurement, materials, and environment.

The 5 Whys is a technique for determining the underlying reason of a problem (Voehl, 2016). It is the habit of repeatedly inquiring why a failure has occurred in attempt to determine its origin. Each time a response is given, one inquires as to why that specific condition occurred (Voehl, 2016). This 5 whys analysis used in order to support the fishbone analysis and to deepen the root cause analysis.

3.1.5.2 Initial Observation

Observing the Finished Goods, specifically the loading area where the final products are prepared for shipment, is the second step in conducting this study.

This is where the vast majority of defective items are found. Attempts were made in order to understand the common cause of the defective items observed in this region through interviews with the supervisor and staff. A large number of defective items and their potential causes are acknowledged in this phase. In addition to the interview, it's important to trace the flow transfer of the goods during filling, packaging, and storage to identify whether the issue only occurs at the loading area.

3.1.5.3 Data collection

The data necessary for the study is gathered in this stage. The intern grants access to the packaging integrity guide from each packaging company. The intern collect data independently on Finished Goods for 3 weeks. In the first week, the intern gained data by recording defective products in finished goods by every truck and also notes their delivery point to calculate the total package observed for calculating % defect. However, by this method, the description of defect is not sufficient, because this method the intern only measures 2nd pack, where the primary packaging is also necessary to assess. Therefore for the next 2 weeks, the data collection will be measured from the defect that has been separated in the corner of the loading station and also records the total truck that has been delivered, hence by recording truck the total number of products loaded can also be obtained by looking at the receipt. With the new method, the intern can deeply observe the defect and give more description of defective product. The data collection was followed by further observation for 1 week including visual observation of the packaging and packaging integrity test. Determining the types of defects was done by visual observation and packaging integrity test. Visual observation was used for defective product found in secondary packaging, Tetra pak®, and Ecolean® primary packaging. The packaging integrity method was used for Tetra pak® since the mechanism allowed it to analyze defect in the multilayer of the Tetra pak® primary packaging. According to Tetra pak® guide book packaging integrity test used in this step is red ink and dissolving test.

1) Red ink - Packaging intergrity test

The "red ink test" detects leaks in packaging using a red ink solution with low surface tension that can easily enter capillary leakage channels. Erythrosine (powder) and the solvent isopropanol are used to make it. 1.5 g of erythrosine and 1000 ml of isopropanol are combined, well shaken, and then left overnight. Ensure that the solution is keep from evaporation. The final step is to filter the mixture with a slow-speed filter. To conduct a red ink test, first split the packaging in half then cleaned and dried. Then, using a syringe, the red ink solution is poured against the walls of the container. If there is a leak in the package, the red ink will bleed through after 1 minute.

2) Dissolving method - Packaging intergrity test

For the next method, 15% NaOH was used as the procedure for dissolving. This technique is used to inspect the Tetra pak® packaging seal. Put the sample in the dissolving solution for at least 6 hours, or until no Al-foil is visible on the top sample, to carry out this technique first, run water over the sample to rinse it. It was easy to remove the inner plastic layer from the exterior lamination and aluminum foil layers. The internal coating and the inner plastic layer of the packing material are the layers that remain after the substance has finished dissolving. With a tissue, completely dry the packaging that has been treated. Analyses of samples could be hindered by the presence of water, therefore ensuring that it is 100% dry. Then, observe the seal visually. If the leak is hard to observe visually, use a pipette to drop red ink into the sample all the way down the seal. Visually inspect the area to see whether there is a leak.

3.1.5.4 Analysis

Once the data has been collected, the analysis can commence. This project used a six sigma approach. It is a practical approach to improve organizational and business performance. Six Sigma performance is the statistical term for a process that generates less than 3.4 defects per million opportunity for defects (Mehrjerdi, 2011). Six sigma is often paired with the DMAIC methodology, however only define, measure, and analyze applied in this study followed by giving solutions for each problem with the consent from the field supervisor and time consideration.

1) Define

Defining the problem is the initial step of analysis. This stage creates a table containing the number of defects and reworks from the Finished Goods department. The next step is to explain preliminary analysis, it includes the results of initial observation and pareto chart. describe the types of defects that may be present in the Finished Goods. The next step is to develop a flowchart to illustrate product transfer, exposure during handling, and potential problem sources. Lastly, Pareto chart is used to point out the most likely defect to occur.

2) Measure

Measuring the research's baseline is the second phase of this analysis. This phase will calculate Defect per unit (DPU), Defect per opportunity (DPO), Defect per million opportunities (DPMO), % yield, and sigma value is essential to see the current status of the process (Pyzdek, & Keller, 2014).

3) Analyze

Third phase is to analyze the reasons for the large number of defects discovered in the Finished Goods of PT So Good Food. First, a Fishbone diagram is created to identify the root reasons for the high number of defects identified in finished items (Kenett, 2008). The Cause and Effect Diagram will next be analyzed using a 5Whys analysis. 5Whys analysis is a method to deeply know the reasons behind reasons of the problem. This may help in identifying the root cause. Even though this analysis is not using sophisticated statistical tools, some researchers agree the useful results can be obtained (Benjamin, Marathamuthu, & Murugaiah, 2015).

4) Giving Solution

This step carries out the solution in order to resolve the problem of the considerable number of defects in Finished Goods. Giving suggestions for improvement based on the cause-and-effect diagram is the first stage. If necessary, testing is then performed.

5) Conclusion and recommendations

The research's conclusion and recommendations for future research are contained in this last stage. The conclusion consists of the objective's answers and a summary of the outcomes of each methodology step.

3.2. Result and discussion

3.2.1 Data Collection

Data collection is when the information gathered from PT So Good Food's Finished Goods department is presented and discussed for research purposes. The Finished Goods department of PT So Good Food has the responsibility to ensure that the products arrive to the consumers in excellent condition and in expected quality. The information in this section of the report was gathered through a series of observations, resources, and interviews.

3.2.1.1 Packaging description

PT So Good Food includes both primary and secondary packaging. Generally speaking, the primary packaging of PT So Good Food Dairy gives containment, protection, convenience, and communication. The package contains the items in a transportable state. Significantly contributes to protecting the environment from products that are transported from place to place. It protects the product from environmental influences such as microorganisms, moisture, ultraviolet light, oxygen, dust, and compressive pressures. To maintain the quality of the food throughout the shelf life of the product and to control the local environmental conditions in order to increase storage life and food safety. As a ready-to-drink beverage, it offers consumer convenience. It serves a communicative purpose because food labels are required by law to be placed on food packaging.

Secondary packaging provides containment and protection for products. It protects the primary packaging from exposure to handling. It gives containment for the primary package and enables convenience in the product transfer process.

1) Primary packaging

PT So Good Food Dairy produces dairy beverages that come with different types of packaging and with various volumes.

Figure 9. Primary packaging utilized in PT So Good Food Dairy.
a) Tetra prisma aseptic® 125 mL, b) Tetra Fino Aseptic® 50 mL, c) Tetra Fino Aseptic® 150 mL, d) Ecolean Air Aseptic® 125 mL, e) Ecolean Air Aseptic® 200 mL.

Figure 9 illustrates the packaging that is used in PT So Good Food Dairy. The first three packages were manufactured by Tetra pak®, while the last two were manufactured by Ecolean®. Both types of packaging are specified as aseptic packaging.

There are 6 layers contained in tetra pak® 1) Outside plastic layer, 2) Paperboard and printing, 3) Lamination, 4) Aluminum foil, 5) Internal coating, and 6) Inside plastic layer illustrated by figure 10.

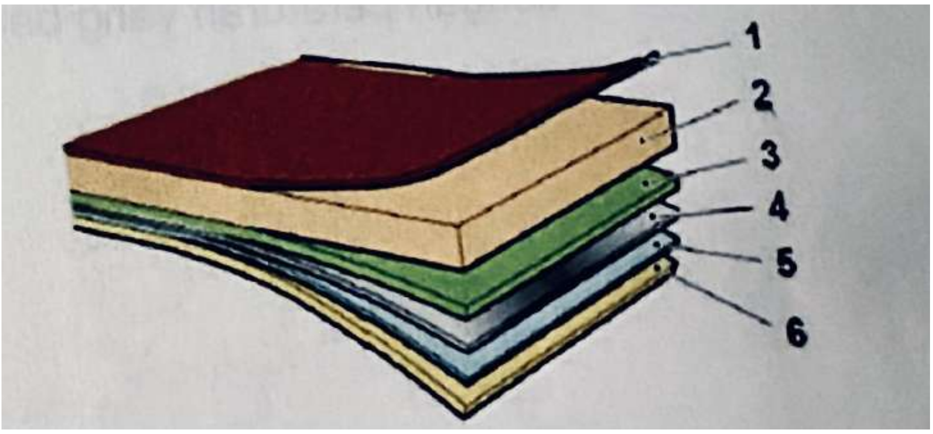

Figure 10. Tetra pak® layers illustration
Sources: Packaging integrity document of Tetra pak®

Outside plastic layer aids to prevent humidity penetrate the aseptic packaging and enables the package overlap and flaps to be sealed. Paperboard gives strength to the package and provides a good printing surface. Lamination is a plastic layer that helps the paperboard adhere to the aluminum foil. The aluminum foil protects the goods from oxygen and light. Internal coating is similar to lamination but adheres aluminum foil to the inner plastic layer. Lastly, the Inner plastic layer keeps the liquid from penetrating into the other packaging material and also enables the package to be sealed.

According to Ecolean® packaging guidebook, Ecolean Air Aseptic® (EAA) is made from 5 layers including PP, Fill, EVOH, Fill CB, and PE.

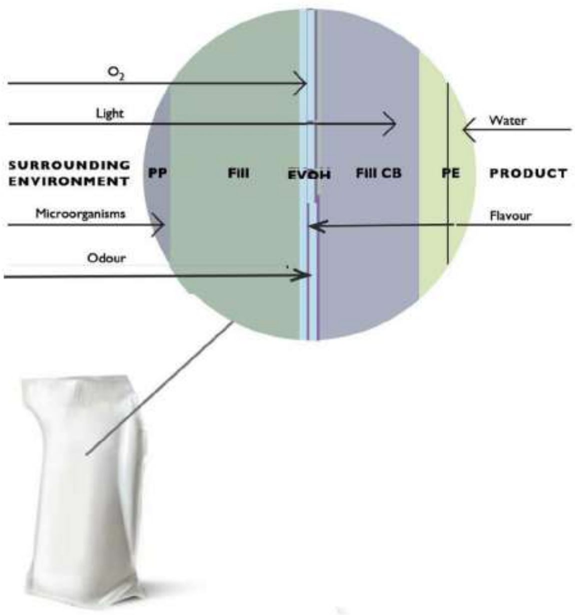

Figure 11. Ecolean® packaging layers
Sources: Packaging integrity document of Ecolean® Packaging integrity document

Polypropylene (PP) is a layer that is robust and durable and has great printing qualities. Fill is a layer of polypropylene with minerals added for rigidity and durability. Ethylene vinyl alcohol (EVOH) serves as an oxygen barrier. Fill CB is a light-blocking coating of carbon black. Polyethylene (PE) has a lower melting temperature and serves as both a sealing and a food contact layer. Besides Polyethylene has a lower melting temperature than other layers, thus when heated the layer melt inside out.

2) Secondary packaging

The primary packaging afterward will be packaged in secondary packaging using corrugated fibreboard. There are 6 different size of secondary packaging shown in Figure 12.

Figure 12. Type of secondary packaging
a) Tetra Fino Aseptic® 50 mL x 60 pcs, b) Tetra Fino Aseptic® 150 mL x 36 pcs, c) Ecolean Air Aseptic® 125 mL x 40 pcs, d) Tetra Fino Aseptic® 50 mL x 48 pcs, e) Tetra Prisma Aseptic® 125 mL x 40 pcs, f) Ecolean Air Aseptic® 125 mL x 40 pcs

Corrugated fibreboard is composed of two exterior sheets and a corrugated-shaped paper in between. (Kirwan, 2012). There are many flute types, the most common flute type is type B, C, and E. Those three flute types are generally the same, the difference is in flute pitch and board thickness.

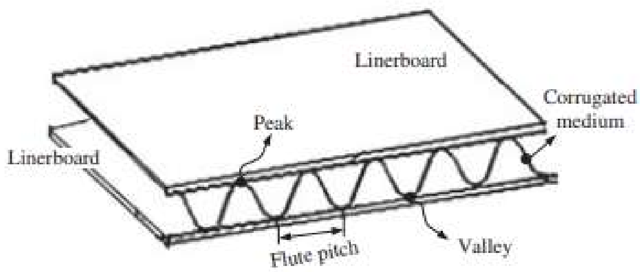

Figure 13. Corrugated fibreboard Structure
Sources: https://onlinelibrary.wiley.com/doi/10.1002/pts.971

PT So Good Food uses flute C type corrugated fibreboard. Flute C type has the most strength for stacking compared to Flute types B and E

(Kirwan, 2012). There are 6 different sizes of corrugated fiberboard used with the corrugated fibreboard thickness of 3-4 mm.

3.2.1.2 Process flow (General)

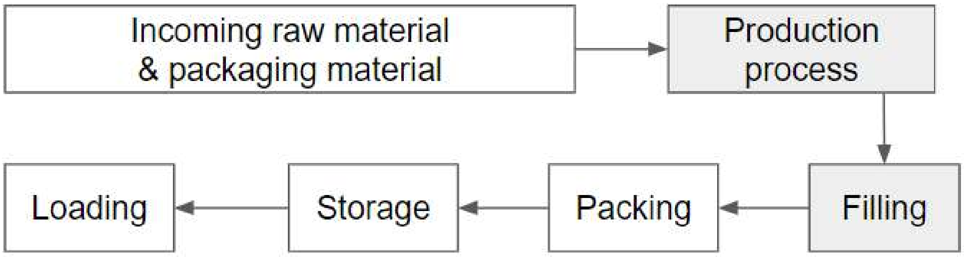

Figure 14. The general process flow diagram in PT So Good Food

Products in PT So Good Food Dairy is primarily produced in the milk processing plant. As depicted in figure 14, the process begins with the arrival of the raw material and packaging material. Before use or storage, all of the material will be inspected by quality control. All of the material will be checked by QC before usage/storage. When the raw materials and packaging materials are prepared, the manufacturing process begins. In the processing plant, the milk will be pasteurized prior to entering the blending tank, where it will be mixed with additional flavoring if necessary. Once thoroughly mixed, the product from the blending tank will be treated with ultra-high temperature (UHT) and then stored in an aseptic tank. Once the product is ready, a signal is sent to the filling machine to begin packing. The filling machine is connected to the packaging room, then the product with primary packaging will be manually packed into secondary packaging, stacked into a palate, wrapped, and transferred to storage/ Finished Goods. In storage, the palette will be racked and unracked if needed to be loaded. The loading process is performed manually by placing each secondary packaging individually into the truck.

3.2.2 Define Phase

This phase explains defects and rejects data from finished goods, and conducts preliminary analysis. The preliminary analysis includes results of finished good packaging defect observation, Pareto chart, and defines the type of packaging observed in PT So Good Food. Therefore by having this phase the problem regarding packaging defects in finished goods can be defined.

3.2.2.1 Defect and rework data from June- September 2022

This section discusses a defect that can be found in Finished Goods. The defective products will either be repacked, reworked, or rejected. Repackaging entails placing the acceptable goods in a new secondary packaging. Reworked means the content of the product will be sent to the processing plant to be reformulated. Rejecting a product indicates that it is no longer commercially viable. Repack and reject are attempts to enhance product value and minimize losses. Table 2 provides a summary of packaging defects from June to September 2022. The most concerning packaging was TFA 150ml with the highest defect percentage (4.55%). However, from a business perspective, the most concerning packaging was TFA 50 ml since the demand for this product was the highest (2447816) which also contributed to the most defect. Nevertheless, based on the average reject rate (25.48%), it can be assumed that the majority of defects occur in secondary packaging; consequently, a substantial amount of the product can be repackaged and sold on the market.

Table 2. Packaging defect and reject data from Finished goods collected from June-September 2022

Packaging Type	Total shipped product	Defect	% Defect	Reject	% Reject
TFA 50 mL x 48 pcs	2447816	17822	0.73%	3562	24.98%
TFA 50 mL x 60 pcs	237981	2070	0.87%	134	6.92%
EAA 125 mL	546681	3118	0.57%	496	18.92%
TPA 125 ml	71638	343	0.48%	103	42.92%
TFA 150 ml	64825	2952	4.55%	1011	52.09%
EAA 200 mL	115269	766	0.66%	191	33.22%
Total	3484210	27071	0.78%	5497	25.48%

Since the data from the finished good department is not specified the occurrence of defect per type of packaging, therefore preliminary analysis conducted.

3.2.2.2 Preliminary analysis

1) Finished good packaging defect observation 23 Agust - 2 September 2022

The intern collects data in the finished goods loading station, by observing the data and recording the amount of defective product, and the total product shipment during observation. The data was summarized in table 3.

Table 3. Finished good packaging defect observation 23 August - 2 September 2022

Packaging type	Primary packaging defect	Secondary packaging defect	Total defective product	Total shipping	% defect
TFA 50 mL	196	700	896	182775	0.49%
TFA 150 mL	87	107	194	5232	3.71%
TPA 125 mL	0	16	16	3450	0.46%
EAA 125 mL	32	333	365	46825	0.78%
EAA 200 mL	31	119	150	25279	0.59%
Total	346	1275	1621	263561	0.62%

Based on table 3 it is summarized the defect occurs in PT So Good Food but also specified the defect by primary packaging and secondary packaging, the complete data about packaging type and type of defect will be found in appendix. 3. The observation has a similar % defect with data from finished goods department June - September 2022 (0.78%), therefore it assumed that % reject also close to the previous data (25.48%). Table 3 states that the most likely defect that occurs in finished goods is secondary packaging of 1275 defective products compared to primary packaging which has 346 defective products.

2) Pareto chart

To concentrate the investigation, a Pareto chart of the product defects is created. The 80:20 rule is represented in a Pareto diagram. According to the Pareto principle, 20% of input is responsible for 80% of the output. Therefore, using this method, the study may be focused on the 20% of defects that are relevant rather than the 80% that are insignificant. The Pareto chart of product defects discovered at PT So Good Food Finished Goods is shown below.

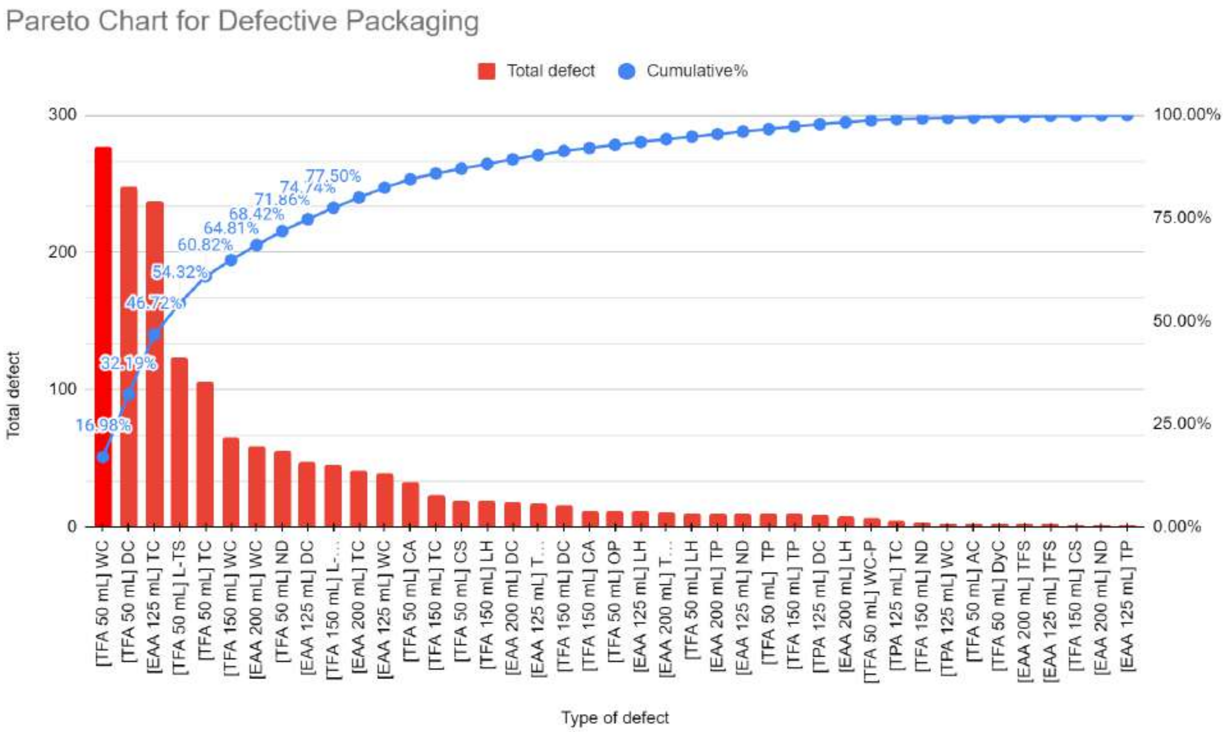

Figure 15. Pareto chart diagram of types of defective products in Finished Goods, data gathered from 22 August to 2 September 2022.

Figure 15 displays a Pareto chart of the various forms of defects in the finished goods of PT So Good Food. Packaging defects exist in 41 different types. The data observed between 15 August and 2 September 2022 in PT So Good Food finished goods. Figure 15 depicts Wetted corrugated fibreboard of TFA 50 mL packaging ([TFA 50 mL] WC) as the most prevalent defect. The second most prevalent defect type is the Dent corrugated fibreboard of TFA 50 mL packaging ([TFA 50 mL] DC), followed by the Tear corrugated fibreboard of EAA 200 mL packaging ([EAA 200 mL] TC). The breakdown of defect until reaching 80% defect as suggested by Pareto principle is shown in table 4.

Table 4. Distribution for the 80% of defective product from the observation from 22 August to 2 September 2022

Packaging type	Defect	Code	Total	Percentage (%)	Cumulative
TFA 50 mL	Wetted corrugated fibreboard	[TFA 50 mL] WC	277	16.98%	16.98%
TFA 50 mL	Dent corrugated fibreboard	[TFA 50 mL] DC	248	15.21%	32.19%
EAA 125 mL	Tear corrugated fibreboard	[EAA 125 mL] TC	237	14.53%	46.72%
TFA 50 mL	Leak in Transversal seal	[TFA 50 mL] L-TS	124	7.60%	54.32%
TFA 50 mL	Tear corrugated fibreboard	[TFA 50 mL] TC	106	6.50%	60.82%
TFA 150 mL	Wetted corrugated fibreboard	[TFA 150 mL] WC	65	3.99%	64.81%
EAA 200 mL	Wetted corrugated fibreboard	[EAA 200 mL] WC	59	3.62%	68.42%
TFA 50 mL	No Duct Tape	[TFA 50 mL] ND	56	3.43%	71.86%
EAA 125 mL	Dent corrugated fibreboard	[EAA 125mL] DC	47	2.88%	74.74%
TFA 150 mL	Leak in Transversal seal	[TFA 150 mL] L-TS	45	2.76%	77.50%
EAA 200 mL	Tear corrugated fibreboard	[EAA 200 mL] TC	41	2.51%	80.01%

The ranking of defects detected in PT So Good Food finished goods are displayed in Table 4. Until this step, it has proven the assumption of defect in the beginning where most commonly occur in secondary packaging. Defect Handling and human error is the most prevalent form of defect detected in the Finished goods of PT So Good Food, as shown by the Pareto chart's findings. Therefore, the study's focus can be narrowed to the most dominant type of defect in the Finished Product Distribution warehouse of PT So Good Food as shown in Figure 4.

3.2.2.3 Types of defects

As stated previously, additional research is required to identify the problematic process step. Identifying the various types of defects is the first step in this process. As a result, a product's defect opportunities might be identified. The Sigma Quality Level may then further be calculated using the opportunities to determine the quality of the process for Finished Goods at PT So Good Food. The defective product was observed from 15 august- 8 September as followed.

1) Primary Pacakaging
   a) Leak, Transversal seal (L-TS)

a) b)

Figure 16. Leak, Transversal seal (L-TS)

a) Red ink test result, b) Dissolving method result

Leakage in transversal seal areas commonly found in the storage, allegedly due to pressure during handling. The transverse seal is a crucial area, therefore it is inspected to determine the location of the damaged area. Figure 16 a) illustrates results of a red ink test that shows leakage in the TS section, then followed by a dissolving test depict in figure 16 b) which reveals the location of the tear. The tear was located right above the seal, meaning that the seal is great, however, the most likely cause is due to pressure during handling.

b) Leak, Hole (LH)

a) b)

Figure 17. Leak, Hole (LH)

a) Tetra pak® packaging b) Ecolean® packaging

A hole might be found in Tetra pak® and Ecolean® packaging. It was shown in figure 17 a and b, respectively. It can happen due to several reasons, such as the bending of the packaging while being packed into secondary packaging. Therefore when it was subjected to friction with other packaging or with corrugated fibreboards it may cause a hole. In the Tetra pak® case it is also possible that in the roller packaging section in the Tetra pak® machine tiny foreign matter falls down thus creating hole.

c) Tear Packaging (TP)

Figure 18. Tear Packaging (TP)

As the name implies, the packaging has a tear, causing the contents to leak; this may be the result of mechanical stress during product transfer. It resulted in the product leaking out and wetting the other packaging and surrounding corrugated fibreboards, leading to rot and a foul odor and appearance.

d) Tear packaging opener (TPO)

Figure 19. Tear packaging opener (TPO)

This packaging opener is ripped therefore the content is released. This issue could be a result of the packaging opener losing its elasticity as a result of being bent while in secondary packaging. This issue leads to contamination of other corrugated fibreboards, rendering them rotten and unhygienic and therefore unacceptable to customers.

e) Crack Alumunium Foil (CA)

Figure 20. Crack Alumunium Foil (CA)

This crack in the aluminum foil indicates that the aluminum foil layer in the Tetra pak® packaging is broken or torn, allowing microorganisms to enter the product and render it unsterile. This can occur if the packaging is crumpled when it is placed in the secondary packaging, or if uneven parts (e.g., there are straws underneath the packaging) are pressed with additional mechanical force when transferring product from one area to another.

f) Tear Factory Seal (TFS)

Figure 21. Tear Factory Seal (TFS)

This package was subjected to forces greater than it could withstand; consequently, the product leaked through a tear near the factory seal. It can be concluded that the factory seal is not the issue, as it adheres perfectly; another reason is that a portion of the packaging was bent when packed into secondary packaging; consequently, it lost elasticity and became easier to break/tear.

g) Crack straw hole (CS)

Figure 22. Crack straw hole (CS)

The aluminum foil layer on the Tetra pak® packaging straw hole is damaged or cracks, allowing germs to enter the product and render it non-sterile. This can occur when the packaging straw hole is crumpled or when adjacent packaging edges come into contact with one another during transport.

2) Secondary Packaging

a) Tear corrugated fibreboard (TC)

Figure 23. Torn corrugated fibreboard

This torn corrugated fibreboard, as namely obviously the corrugated fibreboard is torn as figure 20. shown. This defect is primarily caused when transferring products or when racking or unracking the pallet with a forklift. The secondary packaging is not appealing to be delivered to customers.

b) Dent corrugated fibreboard (DC)

Figure 24. Dent corrugated fibreboard

This dent corrugated fibreboard, as namely obvious. As can be seen in Figure 21, there are serious dents in the box. Using a forklift to rack or unrack the pallet or shifting products are the main cause of this defect. Delivering this product to clients is not desirable.

c) Wetted corrugated fibreboard by leak content of the product (WC)

Figure 25. Wetted corrugated fibreboard by leak content of the product

The figure above shows a wetted corrugated fibreboard that got leaked with another leaked product. The main problem with this is the leaked product, therefore the main goal is to reduce the occurrence of leaked products. As a result, the number of items that require repackaging will be reduced. This defect is not appealing and causes a bad odor when shipped.

d) Wet corrugated fibreboard, fell to the pond (WC-P)

Figure 26. Wet corrugated fibreboard, fell to the pond (WC-P)

Infrequently, however due to human error, the situation will be as described. When loading goods, the Forklift driver puts the goods too close to the truck in an incorrect position therefore when loading the goods and the goods are close to the door, the possibility of the goods being knocked over and enter to the gutter is higher, causing this item to be repackaged because the box was dirty and in bad condition.

e) Disordered Packaging (DP)

Figure 27. Disordered packaging (DP)

The disorderly arrangement may increase the likelihood of a defect; for instance, if a product in TFA packaging is arranged haphazardly, the primary packaging may have a crease, and during the product transfer, this crease may have friction with the corrugated fibreboard or another product. This crease then may cause crack which will either cause the product to leak or the package to expand due to contamination, both of which are extremely undesirable. The figure shows the package overlapping the corrugated fibreboard. If it is arranged in the palette and gets pressure it bursts like it has shown above. The high likelihood of product leakage must be avoided, as product leakage can cause other corrugated fibreboards to become wet and emit an unpleasant odor.

f) Dirty corrugated fibreboard (DyC)
Dirty corrugated fibreboard is caused by a dirty palette. Therefore the dirt in Pallet will not transfer to the cardboard even though it rarely happens in PT So Good Food. However, checking the palette condition is necessary for this problem.

g) No Duct Tape (ND)

Figure 28. No duct tape (ND)

The absence of duct tape in the container constitutes a defect. As depicted in figure 28, this defect is prevalent in finished goods, causing the product to spread during loading. Due to the packaging team's ignorance, this has occurred. Even if the packaging tape on the opposite side of the line runs out, leaving the secondary packaging without duct tape, the product will still be stacked on a pallet. Since this product may be stacked with other rejected things and the cardboard ends up being dirtier, more damaged, and disorganized, this sort of problem may actually be fixed straight away without being sent to a repack room.

h) Asymmetry corrugated fibreboard (AC)

Figure 29. Asymmetry corrugated fibreboard

As this is not a prominent concern, defects of this nature are extremely rare and also rarely observed; however, this affects the truck's arrangement and is therefore undesirable.

3) Flow diagram product transfer

Product transfer refers to the movement of a finished item from one location to another. The product that is loaded for distribution purposes must be in the Ready To Deliver state. Product Transfer Note documents must be utilized in order to monitor product movement within PT So Good Food. The product transfer flow from the work-in-progress to the Finished Goods is shown in the flow diagram below. The product transfer flow from the filling process to the Loading process in Finished Goods is depicted in Figure 30.

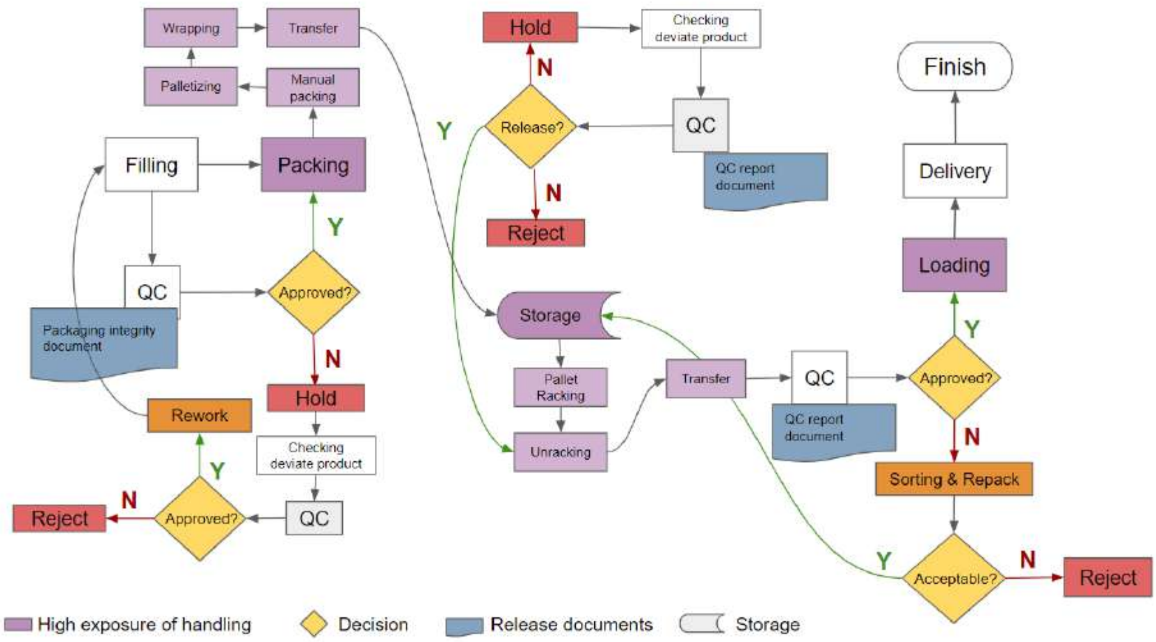

Figure 30. Flow diagram product transfer from filling to loading

The diagram contains various shapes and colors that each have a specific meaning. The color purple indicates that this process will be highly exposed to handling, and a yellow diamond indicates that it is a decision-making process. A blue rectangle with a curved bottom indicates that a QC has released a document. The white oval-like shape with a concave end indicates the presence of a storage item.

As it showed in the diagram above the process starts with the filling process. During the filling process, quality control examines the packcakging integrity, and when the document is released, quality control determines whether the product can proceed to the next step. If accepted, the product will move to the packaging room, and if it is unacceptable, it will be held and checked for deviations. When the quality control department determines that a product can not be used, the product will be rejected and discarded. However, when the product is approved, it can be reworked and returned to the filling machine. Then proceeding into the packaging room. In the packaging room, the product will be manually packed into the secondary packaging then it will seal with the duct tape then manually palletize and wrap with plastic wrap.

In this process supposedly a QC is available to ensure the product is good and ready to be shipped. As a result of no available QC in this process, several unwanted problems occur and they let it be. For instance, the interns discovered through observation that a palette contains a leaking product. However, it wasn't treated right away. Instead, it was merely brought to the warehouse in that condition, consequently, the surrounding corrugated fibreboards got wetted by the leaked product and have the possibility of it affecting more pallets if stacked on top of the rack in storage.

Figure 31. Leak product in packaging room

Continuing the process of product transfer flow, the product from the packing room will be transferred to the Finished Goods to be racked in a pallet storage rack. Then it will be unracked to be delivered, the product will be transferred to the loading station in the loading station before load it to the truck every pallet will be checked with the QC finish good when the QC approves the pallet will be loaded in the truck for delivery when the product is not approved by QC it will be sort and repack and if it’s still not acceptable then it will be rejected and if it is acceptable it will be going into the storage room again.

By define phase known that the finished goods from June to September have a current defect was 0.78% and % reject 25.48%. Therefore, assumption is made, as the % reject low the defect is supposed to be more on secondary packaging. To prove the assumption regarding the defect, whether it mostly comes from primary or secondary packaging, the intern conducted observation from 22 August - 2 September, the results state that % defect is 0.68% which is similar to the data from finished goods department, and the defect found in secondary packaging is much higher than primary packaging. This statement is strengthened by a Pareto chart made from observation from 22 August - 2 September data from 11 most likely defects revealed, only 1 type of defect that occurs in primary packaging which is leak in transversal seal as shown in figure 16. The observed leakage in the transversal seal is not in the seal itself but right about the seal, according to the tetra pak guide book, that problem caused due to handling - shifting stress during product transfer. Defect type and product transfer also cover in define phase, in order to understand the given idea about the product transfer process and the type of defect that occurs in the field.

By having a defined phase it exacerbates the problem. In the analysis phase the analysis will focus on the most likely defect that gained from Pareto chart.

3.2.3 Measure Phase

Following step is the Measure phase. A few equations are undertaken in this step in order to establish the study's baseline and figuring out the existing process capabilities. Knowing the strength of PT So Good Food will help in determining the amount of effort PT So Good Food has to perform to deal with the problem (Raisinghani et al, 2005). This section will include the Sigma Quality Level (SQL) calculations for the period of June to September 2022. This calculation used the defect data from June - September 2022 from Finished goods department as it measures total defects that occur in the process not only to the specific packaging.

The Sigma Quality Level calculation provides a comprehensive overview of the process's capabilities (Hahn, Doganaksoy, & Hoerl, 2000). To determine the Sigma Quality Level of the process, a few procedure calculations must be performed (Montgomery & Woodall, 2008). Calculating Defect Per Unit (DPU) is the initial step before moving on to Defect Per Opportunities (DPO). While Defect Per Opportunities is determined by dividing Defect Per Unit by the number of opportunities, Defect Per Unit is determined by dividing the number of defects and the number of shipments. The Defect Per Million Opportunities (DPMO) is then calculated by multiplying the Defect Per Opportunity by one million (one million).

3.2.3.1 Calculation of DPU

The Defect Per Unit is calculated as the first step in the calculation of the Sigma Quality Level (DPU). Defect Per Unit displays how many products have defects or errors in the total product that loaded (Montgomery & Woodall, 2008). In this case, the unit refers to the number of packaging that shipped. This calculation is made to get an idea of the average number of defects per product that is shipped in finished goods. The defect estimation used in this study is done for all packaging at once.

$$\text{DPU} = \frac{\text{Number of packaging defect}}{\text{Number of packaging loaded}} \qquad (1\text{-}1)$$

$$\text{DPU} = \frac{27071}{3484210} = 0.0078 \text{ DPU} \qquad (1\text{-}2)$$

The formula and outcome of the calculations of Defect Per Unit (DPU) of product in the Finished Product Distribution warehouse from June to September 2022 are shown in equations (1-1) and (1-2). It is evident that the Defect Per Unit, which was calculated by dividing the number of defects between June and September 2022 by the total number of shipments from June to September 2022, is 0.00777. The DPU value (0.00777) shows 0.00777 units of defects are discovered for total product shipment that shipped. The Defect Per Opportunity (DPO) calculation is the following stage in this procedure.

3.2.3.2 Calculation of Defect Per Opportunity (DPO)

The Defect Per Opportunity is calculated after determining Defect per unit (DPU). The amount of defects or errors in each opportunity is shown by the term "Defect Per Opportunity." This formula is made to get a broad idea of the defect rate per opportunity. The overall number of defects (or possibilities for defects) in the Finished Goods is 41, which is divided by 5, which is the kind of packaging that was observed, to calculate the number of defects in this study.

$$\text{DPO} = \frac{\text{DPU}}{\text{Number of opportunity}} \qquad (2\text{-}1)$$

$$\text{DPO} = \frac{0.0078}{(41 : 5)} = 0{,}0095 \text{ DPO} \qquad (2\text{-}2)$$

The formula and outcome of the calculation of Defect Per Opportunities (DPO) of the product in Finished Goods from June to September 2022 are shown in equations (2-1) and (2-2). As can be seen, the Defect Per Unit was calculated using Equation (1-1) and the results was 0.0078 (1-2). When the acquired value is divided by the number of defect opportunities between June and September 2022, the result in equation (2-2), was 0.0095. The Defect Per Million Opportunity calculation is the following stage in this procedure (DPMO).

3.2.3.3 Calculation of Defect Per Million Opportunity (DPMO)

Calculating the Defect Per Million Opportunity is the next step in determining the Sigma Quality Level. Defect Per Million Opportunity displays how many defects there are for every million opportunities. This calculation was made to get a broad idea of the defect rate per million opportunities. For the purposes of this study, a defect calculation is made for each product unit.

$$\text{DPMO} = \text{DPO} \times 1000000 \qquad (3\text{-}1)$$

$$\text{DPMO} = 0.0009475151 \times 1000000 \qquad (3\text{-}2)$$

$$\text{DPMO} = 947.5151 \text{ DPMO} \qquad (3\text{-}3)$$

Equations (3-1), (3-2), and (3-3) demonstrate the equation and results used to calculate the product's Defect Per Million Opportunities (DPMO) from June to September 2022. It is clear that in order to calculate the Defect Per Million Opportunities, the value is multiplied by 1000000, yielding a result of 947.5151.

As a result, there are 947.5151 defects for every million chances. The calculation of the Yield value is the next stage in this procedure.

3.2.3.4 Yields%

The yield value was determined in the second-to-last phase in calculating the Sigma Quality Level. Although there are other forms of yield, the throughput yield, which was the most precise of all yields, is the one used in this study as the calculated yield value (Raisinghani et al, 2005). In order to determine if the Product Transfer procedure is capable of handling products without defects, a calculation is made.

$$\% \text{ Yield} = 1 - \frac{\text{Number of packaging defect}}{\text{Number of packaging loaded}} \qquad (4\text{-}1)$$

$$\% \text{ Yield} = 1 - \frac{27071}{3484210} = 99.2223\% \qquad (4\text{-}2)$$

The calculation of the Product Yield in Finished Goods from June to September 2022 is shown in equations (4-1) and (4-2), together with the formula and output. Using the formula in Equation, it can be observed that the Yield value is 99.2223%. (4-1). According to the outcome, 99.2223% of production units are likely to pass through the Product Transfer procedure defect-free. The Sigma Quality Level will be determined in the subsequent phase of this procedure (SQL).

3.2.3.5 Sigma Quality Level (SQL)

The Sigma Quality Level is determined as the final stage in the calculation process. The Product Transfer process capacity is reflected by the Sigma Quality Level. The process is enhanced as you increase Sigma levels. The calculation for product defects in this study is done per unit.

$$\text{SQL} = \text{NORMSINV}(1\text{-DPMO}/1000000)+1.5 \qquad (5\text{-}1)$$

$$\text{SQL} = 4.6062 \text{ Sigma level} \qquad (5\text{-}2)$$

The formula and output of the calculation of the Sigma Quality Level of the product in Finished Goods from June to September 2022 are shown in equations (5-1) and (5-2). It is clear from Equation (5-1) that the Sigma Quality Level is 4.6062, which was performed using a Google Spreadsheet. The outcome indicates that the Product Transfer process has a process capability of 4.6062, or an average company (Ravichandran, 2006).

By doing this measure phase several data were obtained, DPU value is 0.0078, DPO value is 0.0095, DPMO value is 947.5151, % yield is 99.2223%, and gain Sigma quality level is 4.6062. By this phase the current baseline is gained. The current sigma level is 4.6062. According to Ravichandran, 2006, the sigma level of product process capability in Finished goods of PT So Good Food is classified as process in average company since the average company has 3 - 4 sigma level. The baseline of the performance metric from the Measure phase will then be compared to the performance metric at the end of the Control phase within a specified time frame to determine if substantial improvement has occurred. However, this study was only completed to the point of providing a solution; hence, this present baseline may be used to evaluate the company's current performance and for future projects to determine if this project has increased the company's sigma level.

3.2.4 Analyze Phase

Using a fishbone diagram and whys analysis, the underlying cause of the analysis is found during the analysis phase. The root cause provides an overview of the factor and issue that contributes to the fault. A properly prepared fishbone diagram serves as the foundation for the analysis phase of the DMAIC project road plan since it compiles a large number of potential inputs (Ilie & Ciocoiu, 2010). The 5 Whys is a method for identifying the root cause of an issue (Voehl, 2016). It is the practice of continually asking why a failure has occurred in an effort to pinpoint its source. Each time an answer is provided, the reason why that particular circumstance happened is questioned (Voehl, 2016). This 5 whys analysis is used to complement the fishbone analysis and to go deeper into the root cause investigation.

3.2.4.1 Fishbone diagram

The causes of the large quantity of defective finished goods produced by PT So Good Food are outlined in the Cause and Effect diagram. The packing defect at PT So Good Food 's Finished Goods is the issue that this research is about to solve, and the head of the fish represents it in the diagram. Possible reasons for the issue are included in the bones. The reasons were developed through observations, research, and discussion. There is at least one cause for each factor that increases the likelihood that finished goods may have defects. The causes of each factor—Man, Method, and Material—are stated in figure 32.

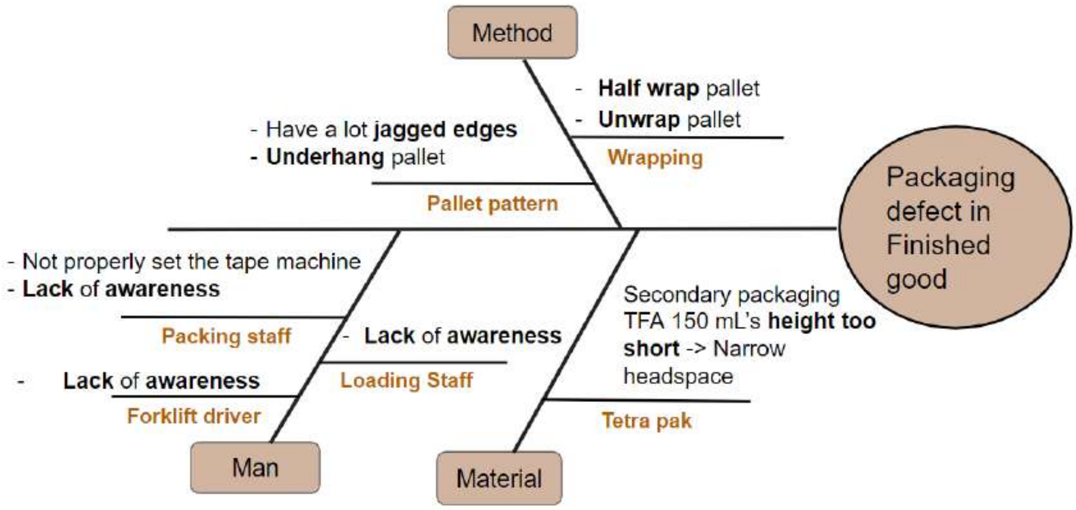

Figure 32. Fishbone diagram

In method the possible issue factor is in the packaging room, including the method of wrapping and palette pattern. The method of wrapping in PT So Good Food use half wrap palette as seen in Figure 33.

Figure 33. Half wrapping pallet method

According to Crampton, 2018, this wrapping method is not optimal as the pallet is not secure. That statement aligns with what is internally observed in the field, where the half palette wrap may not secure the bottom of the palette, consequently, it may be nudged and then cause dents/torn/fall during product transfer. Besides when racking and unracking the palette may get the impact force from the forklift which causes the pallet itself to shift and tilts, hence can cause scratches or dents. Rarely but the intern also found unwrapped pallet in finished good. This problem occur due to there is still leftover in the palette after the demand fulfill during loading. In that case, the palette must be sent back from loading area to finished goods. However, the pallet supposed to be wrapped before racking. The unwrap palette may cause even more severe problems if handled uncarefully, for instance, the pallet may collapse (Crampton, 2018).

Figure 34. Unwrap pallet

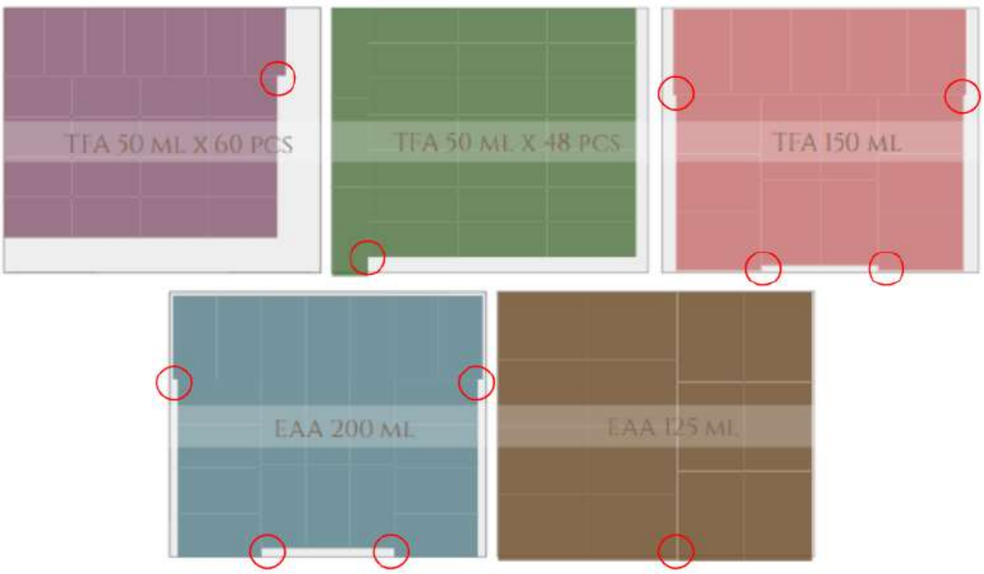

Figure 35. Pallet pattern and the red circle point out jagged edges

For the pallet pattern, there are 2 issues that have been observed. First is the pallet pattern that has lots of jagged edges. As shown in figure 35 the pallet pattern shown the pallet pattern and the jagged edge that point out by red circle. Notice that the pallet pattern for TPA did not show up due to it is not included as the most likely problem in PT So Good Food. The palette pattern with the most right angle is TFA 150 ml and EAA 200ml. The jagged edge may increase potential of the product to hit its surrounding (Bischoff, 1991). The second one is the pallet pattern that has not been optimized because it is underhang as seen in the pallet pattern of TFA 50 ml x 60 pcs. The pallet pattern for TFA 50 ml x 60 pcs got a lot of space that may reduce storage capacity. According to Yi, Chen, & Zhou, 2009 pallet that the underhang may increase the movement of pallets in the storage, therefore, increasing the chance of handling defects.

For the man factor. The biggest issue with Manpower is the lack of awareness. Manpower is crucial since they were responsible for handling, therefore they can directly impact the product, and also there can also be human error. It is possible to conclude that man is the primary reason for the large number of defects because of a lack of awareness and a lack of understanding about the risks.

For the material factor, defects of TFA 150 mL may be caused due to narrow headspace in secondary packaging. That gives the pressure along with the pressure when the product is transferred.

3.2.4.2 5 Whys analysis

Each factor is given a 5Whys Analysis in this section. There are three main elements to the 5Whys Analysis, each representing a different factor. The 5Whys analysis that depicts the Method component is shown in the first Whys chart.

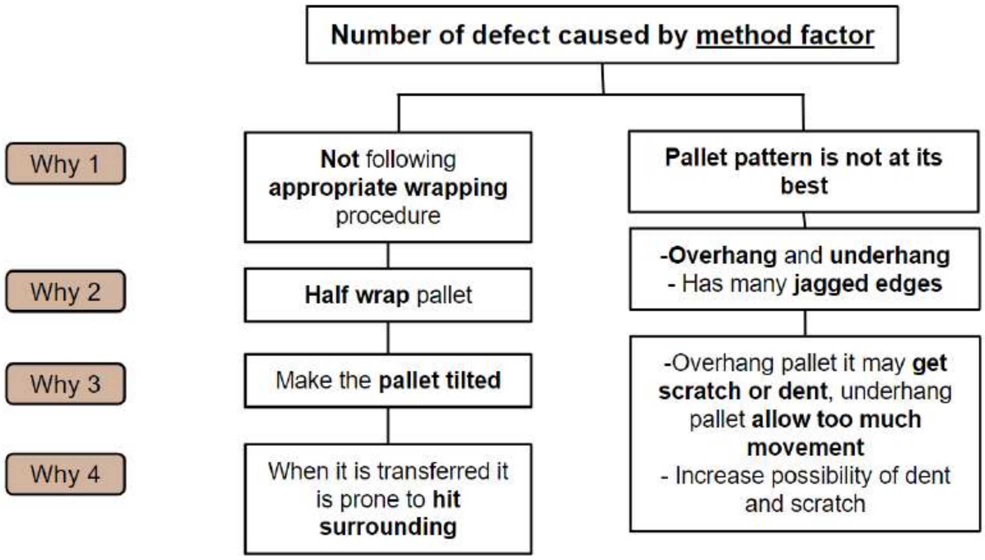

Figure 36 5Whys analysis of method factor

The 5Whys Analysis of Method factor is depicted in the cause-and-effect diagram in Figure 35. The chart includes all of the analyses for each cause. It is clear that the underlying causes of the Method factor may be divided into three categories: product packaging, palletization, and wrapping. For the wrapping method based on observation in the field, the method is by wrapping half of the pallet, based on interview it is done in order to reduce cost, however, According to studies, it is not advised to employ that sort of technique, and things will only become worse if the wrapping is not utilized (Dunno & Symanski, 2021). The half-wrapping or no wrap at all will cause the box in the palette to shift due to the impact when moved using a forklift. Thus susceptible to getting scratched, dented, or even causing the staking to collapse. The palette pattern, still can be modified since there is still, pallet that occupies far less space, in the other hand there are boxes in pallet that exceed the pallet, also there are pallet pattern that has a lot of jagged edges making them prone to dent or scratch. It is recommended not to exceed the pallet, however, if it is so the pallet pattern suppose to have even rectangle shape to reduce the likeliness of dent and scratch.

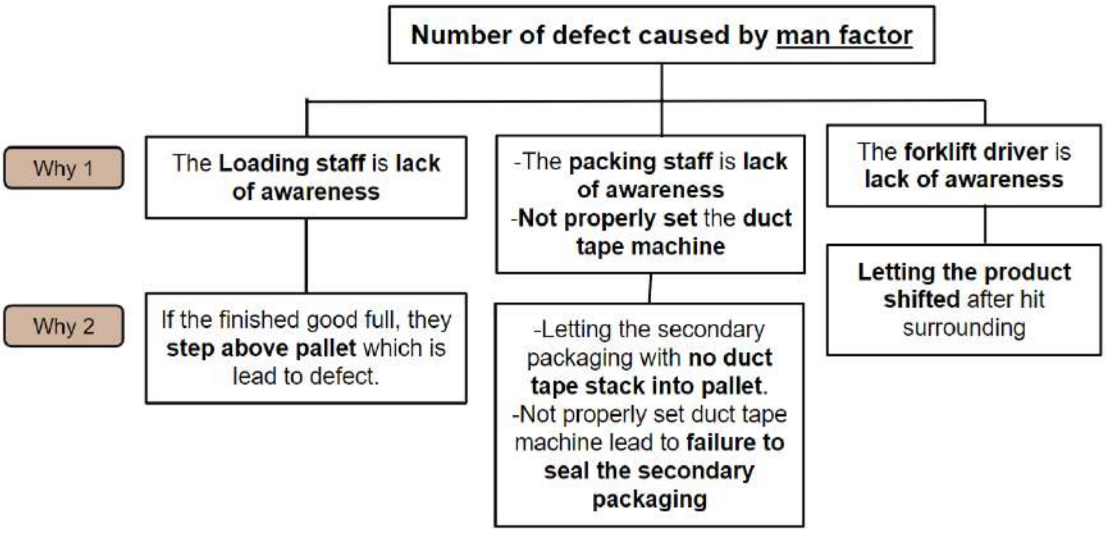

Figure 37 5Whys analysis of man factor

The 5Whys analysis that depicts the man factor is the second element. The cause and effect diagram's 5Whys Analysis of Manpower component is shown in Figure 36. The table lists each analysis for each reason. The lack of awareness of packaging staff did not quickly install the tape that is run out and still put the product into the palette causing problems during loading and creating further defects. Lack of awareness of loading staff, actually they are quite careful, but when the warehouse is full they will go up to the palette to search for products that are listed for loading which should not be allowed. Then for the forklift driver when they take pallet from racking or unracking or transferring product to loading area and the palette is nudged, they don't fix it first, let it be dented, so it's defective.

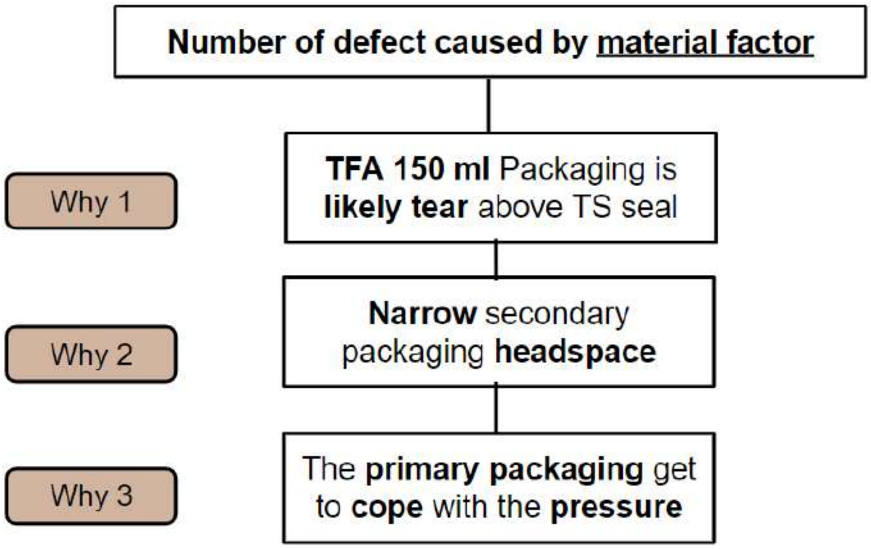

Figure 38 5Whys of analysis of material factor

This 5Whys for material factor shows that the only problem is only the design of the TFA 150 mL corrugated fibreboard where the headspace is so narrow. the height of the box is 11.9 cm and the height of product in the box is 12.15 cm. The height difference between height of the box (12.15 cm) and height of product in the box (11.9 cm) is 0.25 cm. As the primary packaging TFA 150 mL cannot handle pressure >7.2 bar tested using pressure test in filling room and the gap is 0.25 cm where the primary packaging also gained pressure while in box.

3.2.5 Giving solution

Table 5. Solution based on the root cause

No	List Root Cause(s)	List Solutions	Action
1	Dent and scratch secondary packaging	**Pallet optimization**	Making pallet pattern by literature review and designing pattern by using software (stack builder) or doing hands-on.
2	Dent and scratch secondary packaging	**Pallet wrap**	Making alternative wrapping method
3	Carton with No duct tape	Ensure the defective product from the packaging room is **sorted early**.	**Hire qc** in packaging room to minimize further defect by transferring product/ handling
4	TFA 150 mL secondary packaging’s headspace is too narrow	**Increase carton** height	Try to **increase carton height by 0.5-1 cm** and **set carton thickness by minimum 4 mm.**

3.2.5.1 Pallet pattern

For any size of shipping container, there should be a single optimal arrangement for putting units on a pallet so as to cover the largest possible surface while minimizing overhang and underhang on all four sides (Leonard, 1978). The optimal pattern is first established for one tier or layer; the second tier should, if possible, be the inverse or mirror image of the first in order to provide an interlocking effect, similar to how bricks are laid when constructing a wall, which gives the unit load resistance to vibration and shock. The third tier should therefore be identical to the first, the fourth to the second, etc. Failure to define a pallet pattern can lead to chaos in physical inventory control. If operators on various lines or in different factories adopt their own pallet patterns, the number of items per pallet will fluctuate across time and space. It is evident that unit loads with excessive overhang will be too large to move into place (Leonard, 1978). Even worse, if they are packed securely, the loads will settle somewhat during travel due to vibration and vertical shocks, squeezing themselves in so tightly that they cannot be extracted whole. Even if they are constructed with an interlocking pallet design, excessive underhang (more than around 2 inches on a side) can allow for excessive load movement without further stabilization (Leonard, 1978). Consider that 2 inches of underhang on a side multiplied by the length of 14 pallets in a train results in 56 inches of empty space.

Palletizing method is crucial since it loads corrugated fiberboard to be stored in storage. If the pallet pattern is hollow or more than the pallet it will be a problem, if the pallet has a dent, or the outer side is uneven it could be torn if moved using a forklift, so the palletizing method is important to minimizing defeat that occurs by those chances, pallet management It has to be locked, all sides are flat, and it doesn't come off the pallet, and there's no leftovers. There is a several problem with overhangs to even minimize the impact of overhangs to the composition of the pallets or the overhang distribution is divided equally into all four sides so that they are more spread out (Bischoff, 1991). The upward arrangement must be zigzag so that it can lock the pallet arrangement to increase pallet stability so that it does not fall and shake easily (Bischoff, 1999)

For pallet pattern, the optimization is made with the 3 consideration that it must be more symmetrical, has overhang < 2.5 cm, and has interlock pallet stacking. The new alternative pallet pattern is available except for TPA and EAA 200 mL, since TPA is not part of the most likely defects to occur in finished goods and EAA 200mL it has been the most suitable form of palette pattern with the most symmetrical and has no overhang.

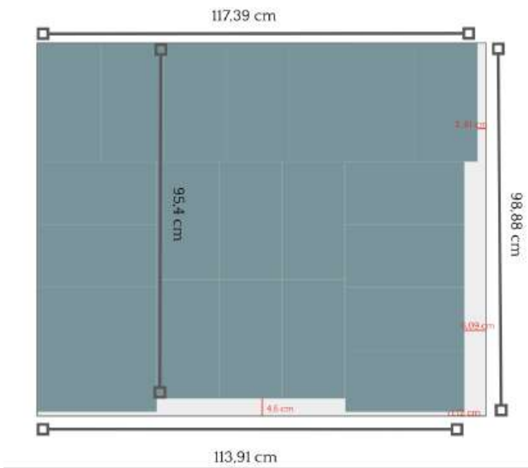

Figure 39. Pallet pattern for EAA 200 mL

Figure 40. Actual pallet pattern for EAA 200 mL

EAA 125 mL got the reduction of load, as seen from figure 42, pallet initially overhang by 2,7 cm and for another side by 3 cm. As the % reject of EAA 125 ml is 0.57 % (3118 box) and % reject is 18.92 % (496) it is assumed that the defect is due to handling mainly defect in secondary packaging, this statement is proven by defect that mostly occur in EAA 125 ml contained in 20% most likely defect in Pareto chart is Tear corrugated fibreboard (14.53%) and dented carton (2.88%). The strength of corrugated fibreboard boxes mostly comes from their corners, which should not extend beyond the edge of the pallet. A 25 mm overhang decreases strength by 14 to 34 % (Vigneault, 2009). Pallet pattern for EAA125 has pin wheel pattern like shown in figure 41.

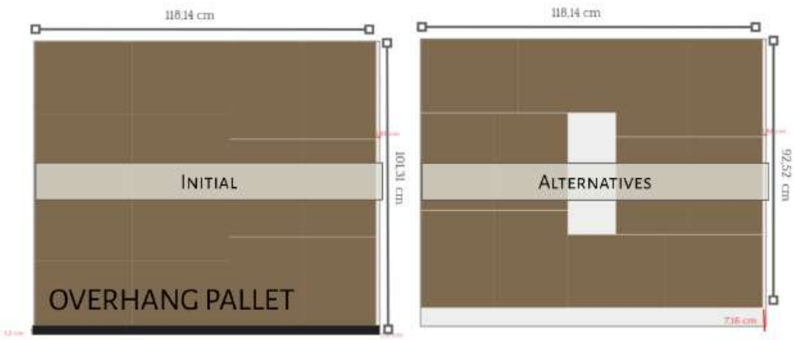

Figure 41. Pallet pattern alternatives for EAA 125 mL

Figure 42. Overhang in initial pallet pattern for EAA 125 mL

Figure 43. Actual pallet pattern alternatives for EAA125 mL

For TFA 50mL x 48 pcs it has increase one box in total box per layer and even though in the figure 44 doesn't look like that, but in figure 45 shows the real look of the pallet pattern more symmetrical. And there is increase in pallete load by 1 box per layer.

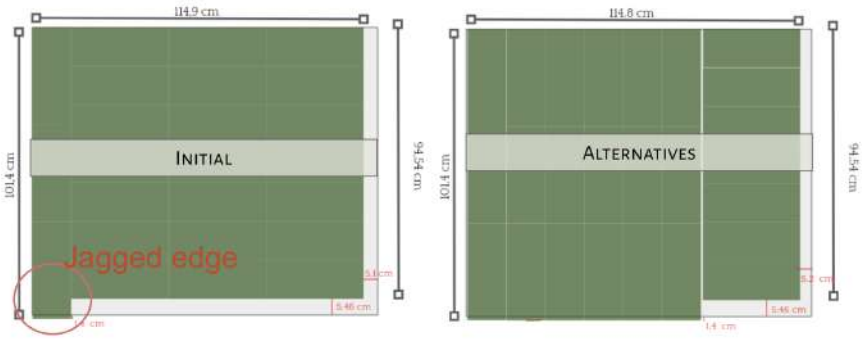

Figure 44. Pallet pattern alternatives for TFA 50 mL x 48 pcs

Figure 45. Actual pallet pattern alternatives for TFA 50 mL x 48 pcs

Figure 45 Shows actuall look of the palette pattern and also points out the overhang or underhang palette by the color code of each side.

For TFA 50ml x 60 pcs there is issue regarding underhang pallet, therefore to maximize the pallet load the pattern change and can increase 6 boxes per layer. Even though there is overhang by 1,5cm. This pallet pattern is good because of the symmetry and there is no overhang and the arrangement on top can be interlocked

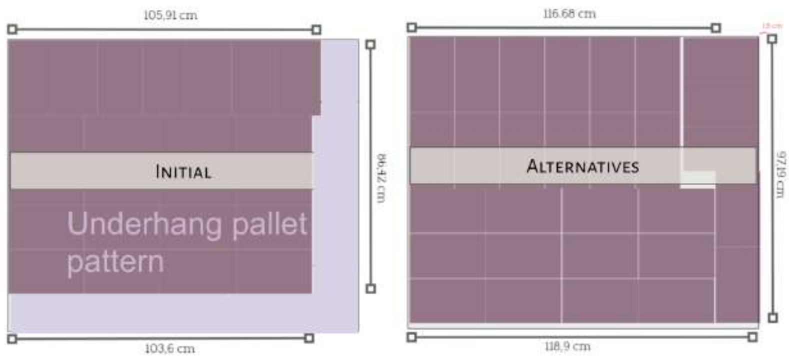

Figure 46. Pallet pattern alternatives for TFA 50 mL x 60 pcs

Figure 47. Actual pallet pattern alternatives for TFA 50 mL x 60 pcs

Figure 47 Shows actual look of the pallet pattern and also points out the overhang side of the pallet by the circle, white color code.

TFA which initially has a lot of jagged edges transformed into perfrcttly rectangle pattern, which is the best pallet pattern alternatives that is the pallet pattern alternatives of TFA 150 ml shown in figure 4 and figure 48 point out space left in the palette is 1 cm.

Figure 48. Pallet pattern alternatives for TFA 150 mL

Table 49. Actual pallet pattern alternatives for TFA 150 mL.

3.2.5.2 Pallet wrap

To support palletization wrapping is necessary in order to secure the formation of cartons in pallet under the influence of shifting stress during product transfer, thus preventing dents or scratches (Bischoff, 1991). Pallet wrap in so good food using half wrap pallet the alternative use fully wrap pallet with minimum possible wrap. As shown in figure 48 the pallet wrap alternative secure pallet from the bottom to the top with a cross arrangement that aims to secure the entire pallet.

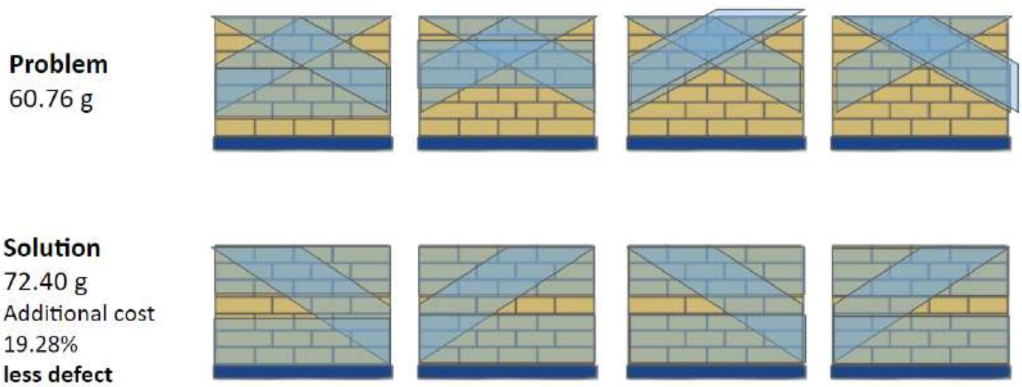

Figure 50. wrapping method alternatives

For the problem with no duct tape and leakage that was found in the packaging room, the solution is to place 1 qc packaging in the packaging room, which has the responsibility for checking a product before going to storage, since you can find lots of boxes that don't have duct tape and you can find a pallet that can fit it's leaking and it's not handled before going to the warehouse, the point is that it should be handled first before the cargo warehouse, otherwise the warehouse will cause further defects

3.3 Conclusion and recommendation

This study uses six sigma approach with Define, Measure, Analyze, and giving solution. By this study, it is concluded that the assumption that the 0,78% of defect with the % reject 25,48% mainly occurs due to defects in secondary packaging is true, and it is mainly due to handling as the secondary packaging get a dent, scratch, and wetted due to leak product that caused by pressure during product transfer. The leak from the primary packaging can be surely stated that it is coming from the handling as the results of packaging integrity prove no defect in the seal. Therefore this study suggested some alternatives to pallet pattern and wrapping, the addition of QC packing, and lastly increasing the height of secondary packaging to reduce pressure on the product. For the future project, this six sigma project can be further analyzed, and conduct the solution and control for the newly developed method to know the increased sigma level by this improvement.

IV. SELF REFLECTION

This internship provided the student with experience in defect analysis, quality control, quality management, and packaging analysis, as this was the company's primary project. This experience improves student’s skill in total quality management, which is essential for a variety of job opportunities and career pursuits, including quality control, QC manager, finished goods supervisor, and project manager. In research activities related to defect student gained a solid understanding of total quality management and packaging analysis through the combination of the internship experience and I3L coursework. Through I3L, students have developed the self-assurance and mental strength required to face obstacles and complete tasks. Through this internship, student also acquired project management, problem-solving, critical thinking, and analytical skills. The development of one's character is supported by the soft skills acquired. The bright session also contributes to the development of student’s soft skills, where students attend bright sessions about being grateful, communication skills, becoming innovative Rnd, which increases the likelihood of being hired for certain roles. Student have come to realize through the internship that the student is detail-oriented person, especially when it comes to explaining things. Student is also regarded as a diligent worker who strives for perfection in all aspects. Through this internship, the student realized that the ability to think analytically is a skill that aids in problem-solving. Moreover, students possess a high degree of adaptability, which enables them to quickly acquire new skills or salvage a failed project. However, one of the weak points is critical thinking, as students occasionally fail to consider the rationale for selecting a particular research approach. However, by trying to critically examine each statement and choice student made while using the approach, student was able to develop critical thinking abilities. The capability to convey ideas effectively is another shortcoming since student struggle with language. If the student had taken more time to carefully select the words and reread the explanation, he or she could have conveyed the current progress and problem to the supervisor and other research assistant more effectively. Students may even assist another intern student or staff member in communicating their explanation to others.

With intern students the company can get fresh ideas for problems that exist at PT SO Good Food. By devoting time, energy, and thought to the project of finished goods packaging defect analysis in PT So Good Food, students come up with several solutions that are applicable in PT So Good Food. Therefore students can give an impact to the change in defect reduction in finished goods and has a direct impact on pallet pattern optimization alternatives and wrapping methods alternatives as steps to reduce defects during product transfer.

V. CONCLUSION & RECOMMENDATION

Through this Internship students learn about the dairy industry, covering QC activity, production process, and packaging defect analysis. By having this internship students gain industrial perspective in conducting research. The intern students accomplish the goals in the beginning of the project which are to point out the most likely defect in finished goods, Analyze root cause and giving solution. The intern can accomplish the task in the it well and stistified field supervisor and academic supervisor. For the future intern it is recommended to make a timeline with SMART method. SMART is abbreviation for specific, measurable, achievable, relevant, and time bounded. By this method the goal setting for the internship can be more organized.

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APPENDICES

Appendices 1. Term of Reference

Terms of Reference (ToR)
for
Internship Program

FR-i3L-AA-2021-07-Rev.1

This term of reference is made between the 1st party:

1. Name of institution : PT. So Good Food Dairy
2. Address : Jalan Raya Randusari Nepen Dukuh Dampit, RT.001/RW.003, Dusun I, Sudimoro, Kec. Teras, Kabupaten Boyolali, Jawa Tengah 57372
3. Company representative/field supervisor name : Hernawati Farida Saptarini. ST,P

And 2nd party:

1. Student Name : Jessica Britney Nelson
2. Student ID : 19010074
3. Study Program : Food Technology
4. I3L supervisor name : Rayyane Mazaya Syifa Insani, S.Si., M.F.Sc.

The 1st party agrees to assign to the 2nd party the following position: Quality Control and Production Intern with the following activity description:

No.	Scope of work/activity	Duration (max 4 months)	Expected outcome
1	Field observation • Processing plan • Filling plant • Packaging plant • Storage and delivery • Water treatment plant • Laboratory	2 week	[As learning experience] Understand the basic principle and brief activity of all department starting from raw material until finish good as well as quality control part.
2	Microbial recontamination project	2 week	[As learning experience] Understanding the difference between microbialtesting for septic and aseptic product and able to identify microbes.
3	Processing in detail	1 week	[As learning experience] Understanding the details of processing including flow, principle, parameter used, and function of each machinery

4	Cleaning in place in detail	1 week	[As learning experience] Understanding the standard operation procedure, type of CIP, CIP step, and parameter.
5.	[Main Project] Finished good project - defect analysis	5 week	[Report and presentation] Understanding the problem during product transfer and profide solution to minimize prduct defect using fish bone diagram.
6	Water treatment in detail	1 week	[As learning experience] Understanding in more advance about water treatment including, flow, steps, parameter.Principle, and mass balance.
7	Sensory room design and panelist	5 week	[Report and presentation] Making design for sensory room and sensory room protocol, also making panelist group.

The 2nd party agrees to finish the task given within the given duration under the guidance of the 1st party and i3L supervisor. The 1st party agrees to guide the 2nd party in accomplishing the tasks. Other activities not covered in this ToR will be discussed between both parties.

Boyolali, dd/mm/2022

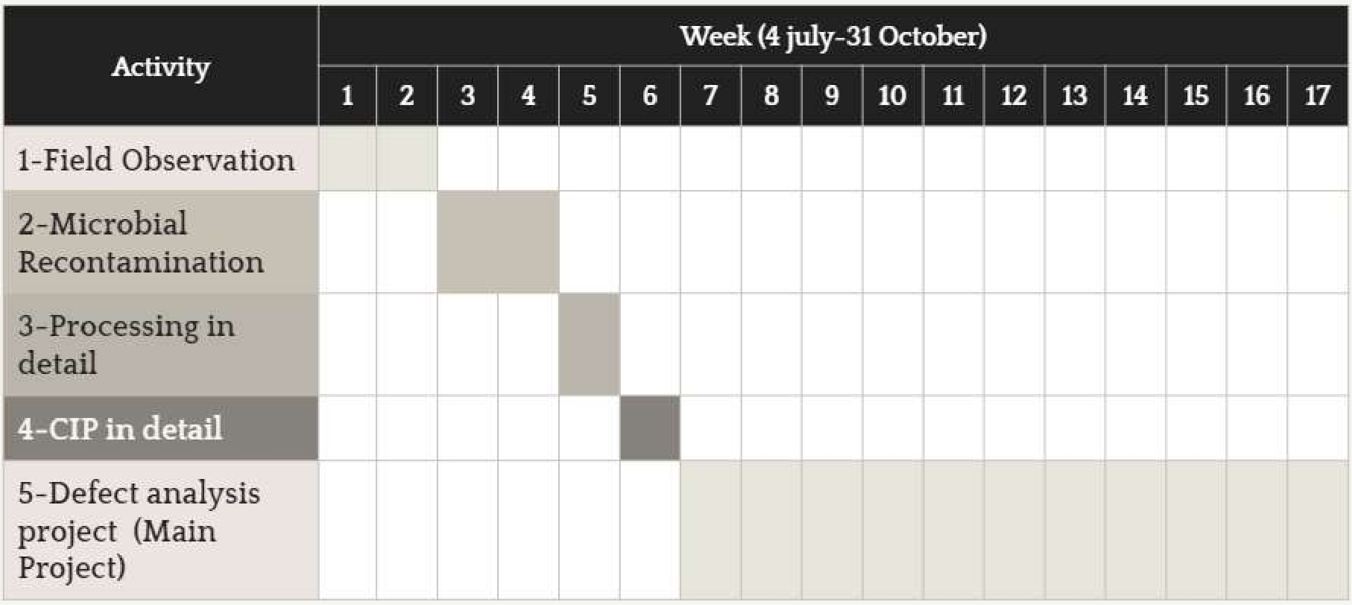
Field supervisor,

Student,

Name: Hernawati Farida Saptarini. ST,P
NIP: 10003289

Name: Jessica Britney Nelson
NIM: 19010074

Appendices 2. Timeline of the internship



Appendices 3. Observation packaging defect 23 Agust - 2 September 2022

NO	Type of packaging	Code	Packaging deefect	Primary /secondary packaging	Defective product	% defect
1	TFA 50 mL	WC	Wetted Corrugated Fibreboard	Secondary Packaging	277	16.98%
2	TFA 50 mL	DC	Dent Corrugated Fibreboard	Secondary Packaging	248	15.21%
3	EAA 125 mL	TC	Tear Corrugated Fibreboard	Secondary Packaging	237	14.53%
4	TFA 50 mL	L-TS	Leak, Transversal Seal	Primary Packaging	124	7.60%
5	TFA 50 mL	TC	Tear Corrugated Fibreboard	Secondary Packaging	106	6.50%
6	TFA 150 mL	WC	Wetted Corrugated Fibreboard	Secondary Packaging	65	3.99%
7	EAA 200 mL	WC	Wetted Corrugated Fibreboard	Secondary Packaging	59	3.62%
8	TFA 50 mL	ND	No Ductape	Secondary Packaging	56	3.43%
9	EAA 125 mL	DC	Dent Corrugated Fibreboard	Secondary Packaging	47	2.88%
10	TFA 150 mL	L-TS	Leak, Transversal Seal	Primary Packaging	45	2.76%
11	EAA 200 mL	TC	Tear Corrugated	Secondary	41	2.51%

			Fibreboard	Packaging		
12	EAA 125 mL	WC	Wetted Corrugated Fibreboard	Secondary Packaging	39	2.39%
13	TFA 50 mL	CA	Crack Alumunium Foil	Primary Packaging	33	2.02%
14	TFA 150 mL	TC	Tear Corrugated Fibreboard	Secondary Packaging	23	1.41%
15	TFA 50 mL	CS	Crack Straw Hole	Primary Packaging	19	1.16%
16	TFA 150 mL	LH	Leak, Hole	Primary Packaging	19	1.16%
17	EAA 200 mL	DC	Dent Corrugated Fibreboard	Secondary Packaging	18	1.10%
18	EAA 125 ml	TPO	Tear pack opener	Primary Packaging	17	1.04%
19	TFA 150 mL	DC	Dent Corrugated Fibreboard	Secondary Packaging	16	0.98%
20	TFA 150 mL	CA	Crack Alumunium Foil	Primary Packaging	12	0.74%
21	EAA 125 mL	LH	Leak, Hole	Primary Packaging	12	0.74%
22	TFA 50 mL	OP	Packing Disorder	Secondary Packaging	12	0.74%
23	EAA 200 mL	TPO	Tear pack opener	Primary Packaging	11	0.67%
24	TFA 50 mL	TP	Tear Packaging	Primary Packaging	10	0.61%
25	TFA 50 mL	LH	Leak, Hole	Primary Packaging	10	0.61%
26	EAA 125 mL	ND	No Ductape	Secondary Packaging	10	0.61%
27	EAA 200 mL	TP	Tear Primary Packaging	Primary Packaging	10	0.61%
28	TFA 150 mL	TP	Tear Primary Packaging	Primary Packaging	10	0.61%
29	TPA 125 mL	DC	Dent Corrugated Fibreboard	Secondary Packaging	9	0.55%
30	EAA 200 mL	LH	Leak, Hole	Primary Packaging	8	0.49%

31	TFA 50 mL	WC-P	Wet Corrugated Fibreboard, fell to the Pond	Secondary Packaging	7	0.43%
32	TPA 125 mL	TC	Tear Corrugated Fibreboard	Secondary Packaging	5	0.31%
33	TFA 150 mL	ND	No Ductape	Secondary Packaging	3	0.18%
34	TFA 50 mL	AC	Assymetry Carton	Secondary Packaging	2	0.12%
35	TFA 50 mL	DyC	Dirty Corrugated Fibreboard	Secondary Packaging	2	0.12%
36	EAA 125 mL	TFS	Tear Factory Seal	Primary Packaging	2	0.12%
37	EAA 200 mL	TFS	Tear Factory Seal	Primary Packaging	2	0.12%
38	TPA 125 mL	WC	Wetted Corrugated Fibreboard	Secondary Packaging	2	0.12%
39	TFA 150 mL	CS	Crack Straw Hole	Primary Packaging	1	0.06%
40	EAA 200 mL	ND	No Ductape	Secondary Packaging	1	0.06%
41	EAA 125 mL	TP	Tear Primary Packaging	Primary Packaging	1	0.06%
Total					1631	100.00%

Appendices 4. Microbial recontamination project documentation

Appendices 5. Finished good project documentation

Appendices 6. Final presentation documentation

Appendices 7. Turnitin results