Six Sigma Approach to Reduce Revenue Leakage in Revenue Recognition Process: A Case Study

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ABSTRACT: This study investigates business process inefficiency of revenue recognition process at **Gajah Logistics**, which impact to financial loss. The primary objective of this research is to improve the business process of revenue recognition process, with the purpose to reduce revenue leakage using Six Sigma approach. Six Sigma DMAIC methodology was used as foundation of the problem-solving approach, while in each process Six Sigma Tools also applied.

The study conducted in five main approaches following the DMAIC methodology. First, business process related to defined into business process mapping on a swim lane visualization. Secondly, the fault factors measured using Fault Tree Analysis (FTA) and prioritized using pareto analysis. Third, each faut basic event analyzed using inferential statistics. Then the gap analysis conducted to improve with benchmarked state of the art. After that, solution was formulated and prioritized using effort-impact matrix. Finally, the post implementation impact was simulated to give new baseline of the process quality.

The overall process quality measured by DPMO at the current state was 2.5 sigma level, which was causing a huge loss to the company. After implementing sigma level is improved to 3.5 sigma level, while the loss reduce 76%.

The research conclude that Six Sigma approach could give company systematic approach to solve the complex and cross functional process inefficiency. The results also showed that if an organization applies effort-impact analysis, it obtains valuable information necessary to support decision-making processes.

KEYWORDS: Business Process, DMAIC, Fault Tree Analysis, Revenue Leakage.

INTRODUCTION

Indonesia's e-commerce industry has experienced exponential growth, underpinned by a burgeoning middle class, increasing internet penetration, and a youthful demographic. As a result, e-commerce has emerged as a significant contributor to Indonesia's economic development. E-commerce era has had significant impact on many industries in consumer retail in Indonesia, one that has significant impact is logistics services. When customers demand faster and flexible services, logistics industries evolve and develop new industry, which now called as e-commerce logistics. E-commerce logistics plays a crucial role in ensuring customer satisfaction, as it directly affects factors like delivery speed, accuracy, and the overall shopping experience.

Gajah Logistics (GL) is one of E-commerce Logistics company in Indonesia. Gajah Logistics has evolved into a separate entity to be more focused on conducting logistics business. As part of Gajah Group, Gajah Logistics support a series of business within ecosystem, such as Fulfillment, Delivery, E-Retail Business, and Distribution.

BUSINESS ISSUE

As Gajah Logistics Delivery Business just launched in mid-2022, the hype grows exponentially since it absorbs captive market from E-commerce Platform Seller, but meanwhile business process and technology still lag. One of the most significant gaps in the business process is Revenue Recognition Process, which the most critical part of the process in the business. Revenue leakage is defined by the discrepancy between the shipping fee from customer to E-commerce Platform. This happen because there is a lot of misalignments in multi entity interaction.
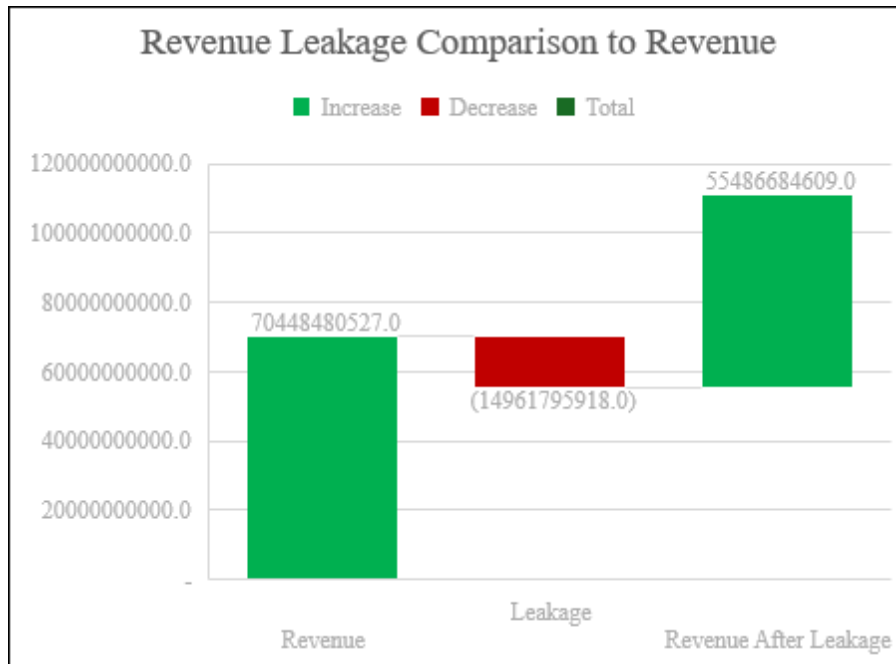
Figure 1: Revenue Leakage on Q1-Q3 2023 in Gajah Logistics

Revenue leakage on Q1-Q3 2023 has already eaten up 21% of the delivery services revenue, which is a huge amount of money compared to overall revenue. Moreover, indeed it will eaten up the net profit. According to CSI Market on logistics and transportation industry analysis, the trailing twelve months basis gross margin in 2023 is 95.43 %, while the net margin is 4.87 % (CSI Market, 2023). While comparing to the benchmark, GL will have a struggle ahead to get profit, since the revenue already cut by 21% because of leakage.

Since the revenue leakage happen in revenue recognition process, the quality of the process is play a vital role in GL profitability aspect. The quality of the reconciliation process could be identified as good process and defect process. this research will aim to reduce the loss that caused by revenue leakage on shipping fee with six sigma approach.

RESEARCH OBJECTIVE

This study is intended to conduct the business process improvement of revenue recognition process through six sigma approach. To support the decision- making, the author will aim objective as follow: define and measure the current state of process quality in shipping fee reconciliation process in GL Delivery. Analyze the root cause of the problem occurring in shipping fee revenue leakage in GL Delivery reconciliation process. Build the improvement and control plan strategy to reduce the shipping fee revenue leakage in GL Delivery.

LITERATURE REVIEW

A. Six Sigma Framework

The term "sigma" is derived from statistics. It refers to the standard deviation of a random variable around its mean value. As a result, Six Sigma denotes six times the standard deviation distance. A process cannot produce more than 3.4 defects per million opportunities to achieve Six Sigma. A defect is defined as anything that does not meet the customer's expectations (Moosa & Sajid, 2010). As a result, it's very important to measure the number of defects and eliminate them to improve quality. Defect per million opportunities (DPMO).

Six-Sigma is a systematic approach to improving the quality of operations and products. To perform Six Sigma quality initiative, the essential component of a data-driven quality strategy for process improvement is DMAIC. The acronym DMAIC stands for define, measure, analyze, improve, and control.

B. Fault Tree Analysis

Fault Tree Analysis (FTA) is top-down method system-level risk assessment procedure to determining the cause or causes of system. FTA also determine interaction between basics event that affecting the system fault.

C. Pareto Analysis

The foundation of Pareto analysis is the notion that 80% of a project's benefits may be obtained with 20% of the work; on the other hand, 80% of issues can be linked to 20% of their causes. A strong tool for decision-making and quality assessment is Pareto analysis. It is, in the broadest sense, a method of obtaining the information required to prioritization.

D. Chi-square Test

The statistician uses the Chi-Square test to determine how closely the measured data for a given distribution resembles the theoretical data whenever the variables are nominal and independent. It compares two statistical data sets, to put it briefly. This test also assesses how closely the values obtained and the expected values match.

E. Paired T-Test

A t-test is a statistical test that is used to compare the means of two groups. It is often used in hypothesis testing to determine whether a process or treatment has an effect on the population of interest, or whether two groups are different from one another.

F. Impact Effort Matrix

Once the root cause has been determined, you can take appropriate action with the aid of an advanced root cause analysis (RCA) tool called the impact effort matrix. It offers responses to the query of which solutions appear most likely to be implemented with the greatest impact.

RESEARCH METHODOLOGY

As the research will be focused on quality improvement that use Six Sigma approach, hence the research methodology will be adopting the Six Sigma framework. On the big picture methodology is DMAIC, or Define, Measure, Analyze, Improve, and Control, with on each phase will have several steps to enrich the research.

The first phase of the research design flow started with Define phase, which consist of several steps such as case study of prior Six Sigma methodology, stakeholder interview, business process mapping, and exploratory data analysis. The goal of Define phase itself is to define and scoping the problem and the goal of the research. By having clear definition and scope of the problem, research will have clear direction to address the problem.

On the first steps, case studies often reveal the best practices adopted by other organizations. This includes the tools and techniques they used, as well as the organizational culture and leadership support that contributed to its success. Different industries may face unique challenges when implementing Six Sigma. Case studies specific to a particular industry can provide insights into overcoming industry-specific hurdles.
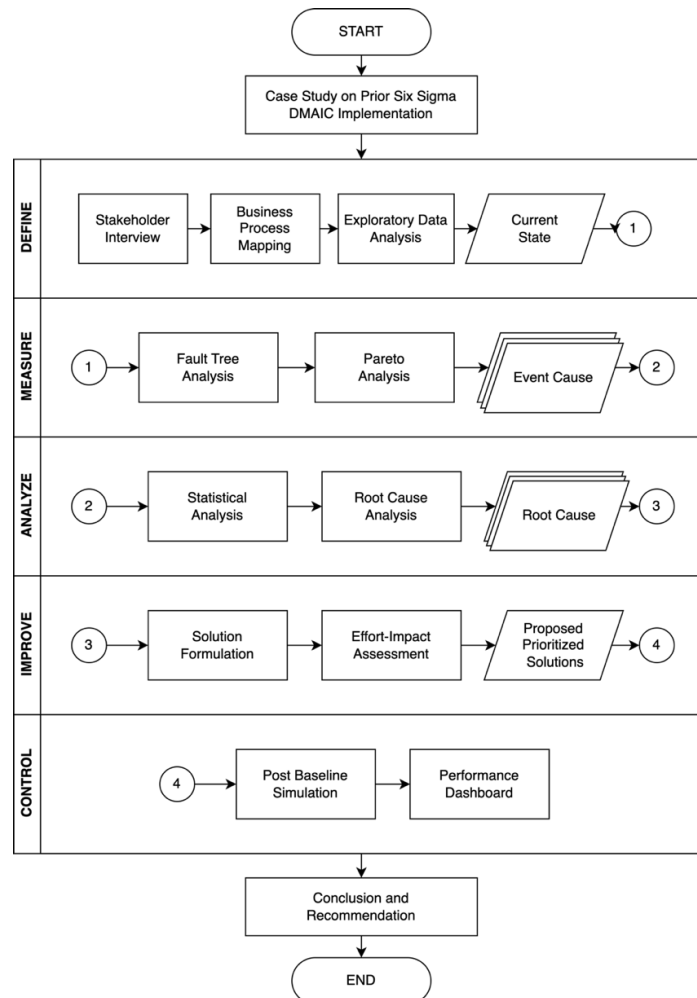
Figure 2: Research Methodology

On the next steps, stakeholder interviews allow researchers to capture a range of perspectives from various stakeholders. This diversity of views is essential for a well-rounded analysis, ensuring that the research considers different interests, concerns, and experiences related to the topic. Once stakeholder interview has already done, it can be documented into business process mapping. Once the data can be defined, it can be explored by Exploratory Data Analysis (EDA). EDA helps researchers and analysts identify patterns, trends, and anomalies within the data. This is crucial for understanding the underlying structure of the information and gaining insights into business operations. EDA can identify areas for improvement within the data, and business process mapping can pinpoint corresponding opportunities for process optimization. The integration of these insights supports a cycle of continuous improvement in organization.

The second phase of the research design flow is Measure phase, which consist of several process as follow Fault Tree Analysis (FTA) and Pareto Analysis. The goal of Measure phase is to measure with several metrics of the status based on define phase. The first step is FTA, which provides a structured and systematic method for analyzing the causes of a specific event or system failure. It helps to break down complex scenarios into manageable components and allows to visualize interactional between events.

After observed problem has measured, Analyze phase will play a vital role to to identify the root causes of the issues or variations in the process. This involves a thorough examination of data collected during the Measure phase to pinpoint the factors that contribute to the observed problems. The Analyze phase employs various data analysis and statistical tools to examine patterns, relationships, and trends in the data. This includes tools such as histograms, scatter plots, and hypothesis testing. On this research, the tools will be generated using Python 3.0, since the tools has simplicity and well-known open source.

Finally, the last phase is Control phase which is the final stage in the DMAIC (Define, Measure, Analyze, Improve, Control) methodology. The Control phase focuses on sustaining the improvements made during the previous phases and ensuring the continued success of the improved process. Control phase activities include establishing monitoring and measurement systems to track key performance indicators (KPIs) relevant to the improved process.

Control processed will be use Business Intelligence (BI) dashboard. A business intelligence (BI) dashboard is a visual representation of key performance indicators (KPIs), metrics, and other important data points that provide a quick and easy way for businesses to monitor performance and make informed decisions. BI dashboards consolidate and display data from various sources in a visually appealing and easily understandable format, such as charts, graphs, and tables.

RESULT AND DISCUSSION

Shipping fee leakage can be defined as the discrepancy between the shipping fee from customer to E-commerce Platform, with the shipping cost actual, what's being charged by GL to E-commerce Platform. When the numbers between charging from both party are different, then it defines as defect process. Based on sigma DPMO calculation, the population of 4.1 million invoice data examined and visualized to line chart on   Figure **3**. The sigma level of the process quality is still under 3-sigma, or still poor. This metric is very concerning considering that the defect will damage the company in monetary value. Additionally, from the figure below, it shows that sigma level was consistently under 3 sigma, despite the number of package was increasing.
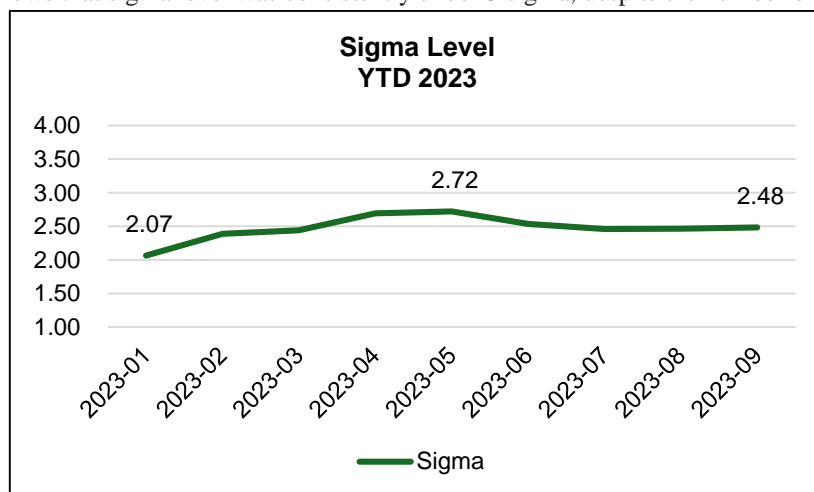

Figure 3 Sigma Level Existing Process

The term "sigma level" describes the population's standard deviation. The number of times a given feature's standard deviation falls into the middle of the tolerance field is determined by the sigma level if the distribution of that characteristic is described by a normal distribution (Kosieradzka & Ciechańska, 2018). In Q1 to Q3-2023 itself, the company must bear the cost of at 14 billion rupiah as revenue leakage impacted. The shipping fee revenue leakage has already eaten up 21% of the delivery services revenue, which is a huge amount of money compared to overall revenue. Moreover, indeed it will eaten up the net profit.

To breakdown the cause of shipping fee revenue leakage, the failure event defined as actual shipping fee is bigger than paid shipping fee from customer. It means what customer paid, is couldn't paid the actual cost that occur for one package. The variable that related to this event could be 2 possibilities. Which are chargeable dimension weight not matched or price per kg for one package is not matched. From this possibilities, FTA plays a vital role to examine from event to each basics event.

The detail of explanation of each basics event explain as follow:

1. Price per kg not matched happen because there is a possibility of error in WMS regarding the config that set service and region code based on rate card from delivery team. Configuration of rate price per kg is predefined set from delivery team before transaction occur, so this config cannot change during operational running. When the order is spiking, there is a possibility that error happen in the integration process and resulted in config error. So on this case, the basics event is system integration error.

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2. Seller input wrong weight means as seller input product's weight manually on e-commerce platform, it could be possibility that they input wrong number. Some possibilities could be unstandardized scale that seller use to scale product weight or human error. This lead to understated on chargeable dimension weight on platform side.

3. Seller not input product dimension in the platform. As explained on business process mapping previously, data input for product's dimension is an optional, not required. This lead to understated on chargeable dimension weight on platform side.

4. Error in package weigh-in happen after packing process done. By nature, every order there is process to pick and pack. Package is expected to have more weight or volume than its original product. Since when operational team packing the product, they add additional safety component, such as shredded paper or bubble wrap.

5. Packer failed to follow instruction. This happen because packer who pack the order did not follow the packaging recommendation by WMS. It happens because of two possibilities. First, packer see the packaging is too tight, so they decide to change the packaging, or secondly human error.

6. Wasted space is too high, this happen because of the packaging provided for product is too big. So there is a lot of space inside the packaging that unutilized.

After, these basic events defined, these basics event would be measured by monetary impact that affected from these basics event. After that, the amount of loss that impacted from basics event will sorted by pareto analysis to give a clear visualization which events that give significant impact to the shipping fee revenue leakage.
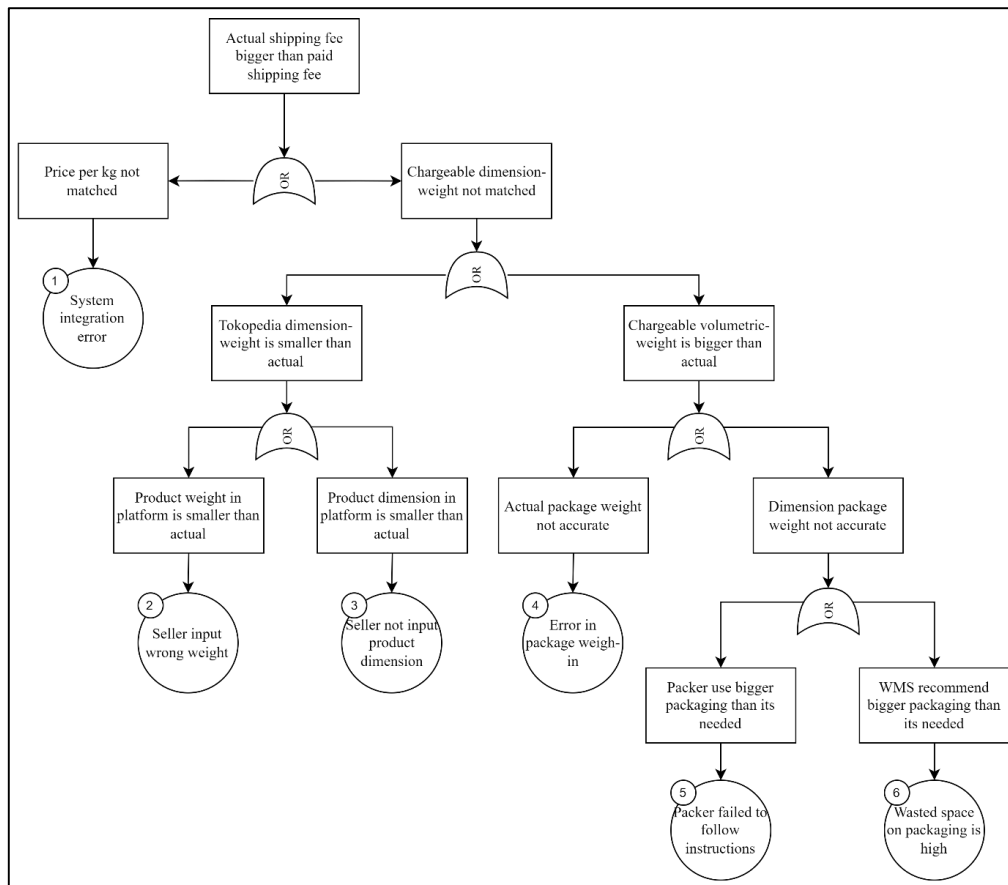

Figure 4: Fault Tree Analysis on Shipping Fee Leakage

After the basics event measured, the next step is to sort from high impact to low impact. Finally, 80-20 rule can be applied to prioritize the significant impact. The pareto 80% of shipping fee revenue leakage is coming from several fault basic events.
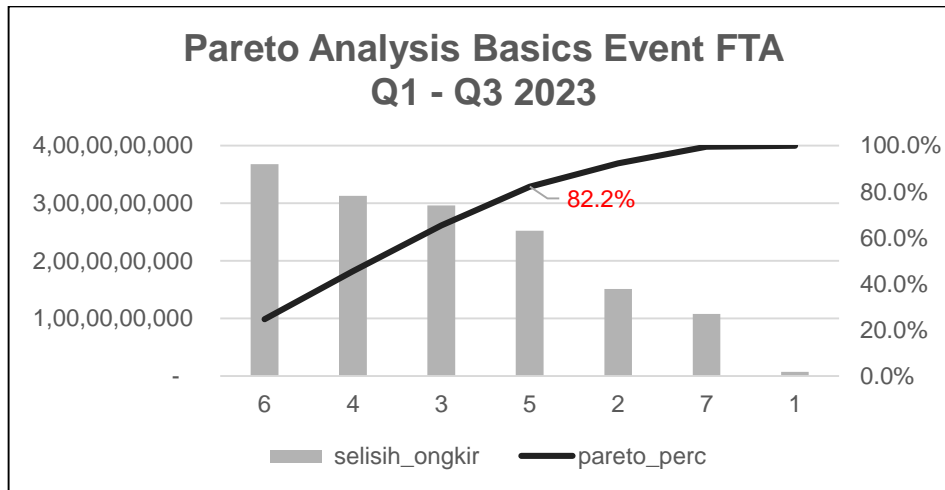
Figure 5: Pareto Analysis on Revenue Leakage based on FTA Basics Event

Pareto Cause #1: Wasted Space on Packaging

Wasted space on packaging is inevitable because the fulfillment centers has a limited choice of packaging types. Wasted packaging occurs when the items being shipped do not fill the available space in the container efficiently, leaving empty spaces or gaps. This can result in higher shipping costs, as more packaging material and larger containers may be required to accommodate the same amount of paid shipping fee by customer.
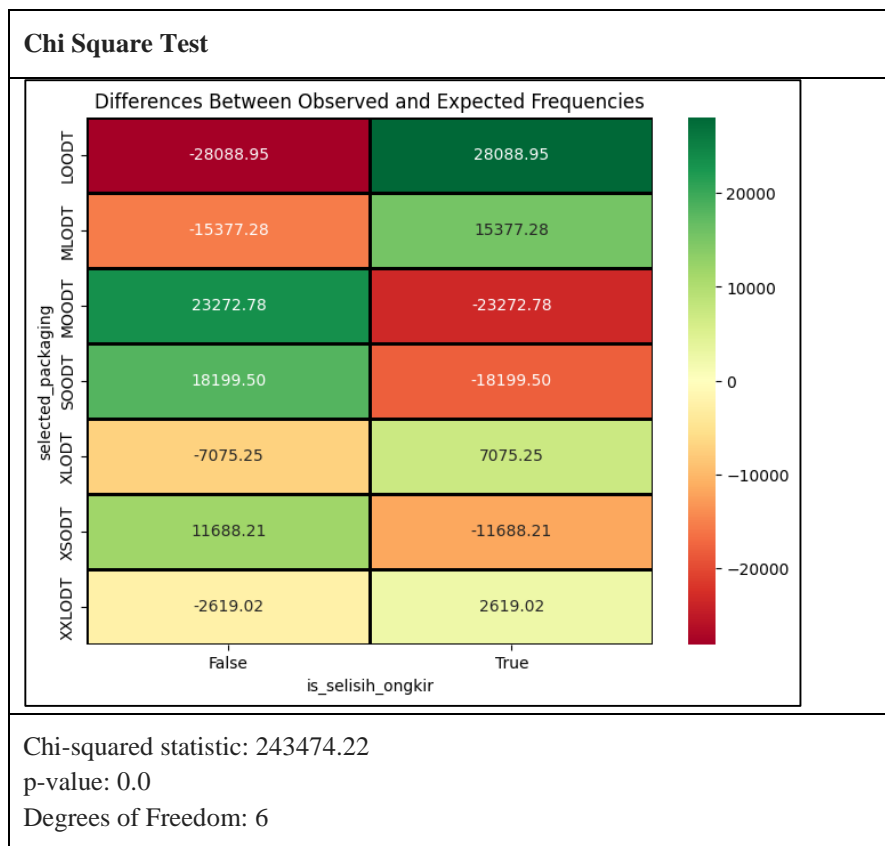

Figure 6: Chi Square Test on Occurrence of Revenue Leakage based on Packaging

The chi-square test is resulted in reject the null hypothesis, means that there is a significant association between the packaging type and the revenue leakage occurrence. After the significancy association has already known, the test continued to one-way ANOVA test.
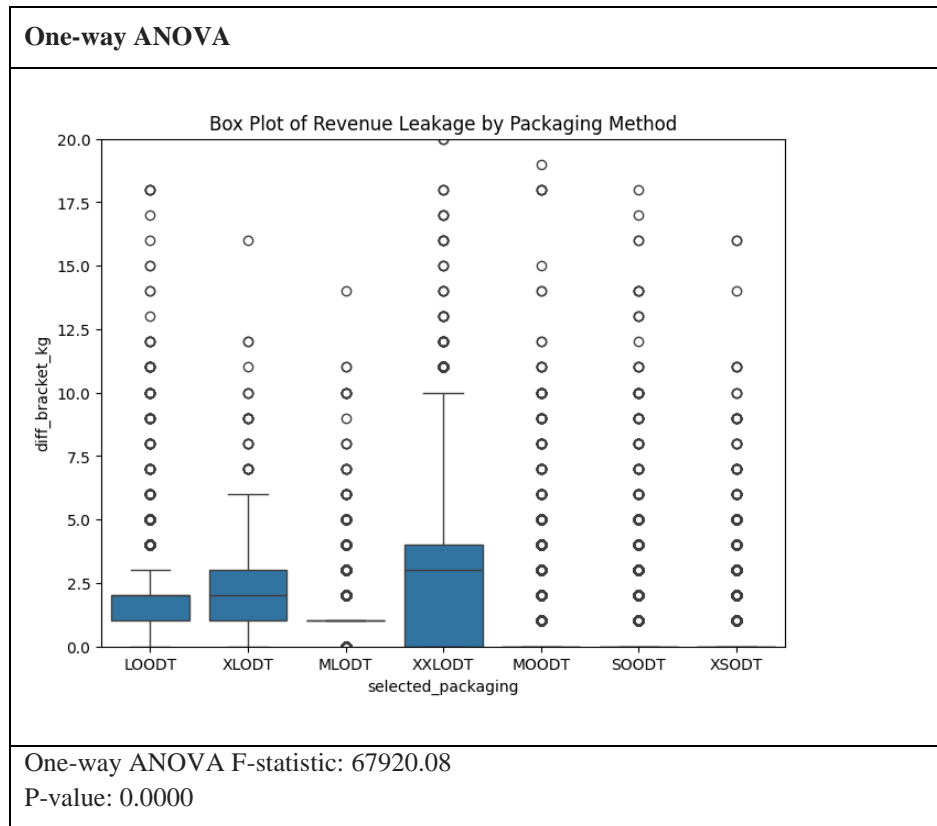

Figure 7: One Way ANOVA on Packaging Type Impact to Revenue Leakage

Based on One-way ANOVA, it found that ML, L, XL, and XXL packaging type has more significant impact to the shipping fee leakage. Referring to **Error! Reference source not found.**, those packaging types are packaging that assigned for orders that have more than one kg or big packages.

Pareto Cause #2: Error in package weigh-in

Error in package weigh-in defined as comparison between e-commerce platform weight and actual weigh-in measurement. E-commerce platform weight is input by Seller, meanwhile actual weigh-in measurement is measured with actual weight when products outbound from the warehouse.

Based on paired t-test, it found that there is a significant difference between e-commerce platform weight and actual weight with mean difference abound 344 grams. This also supported from post-hoc test on Bland-Altman Plot, that shows the mean difference is on 344 grams.

Referring to statistical test above, this can be concluded also that difference comes from additional component for packaging. This indicates that there should be evaluation on aligning between e-commerce weight with actual outbound weight.
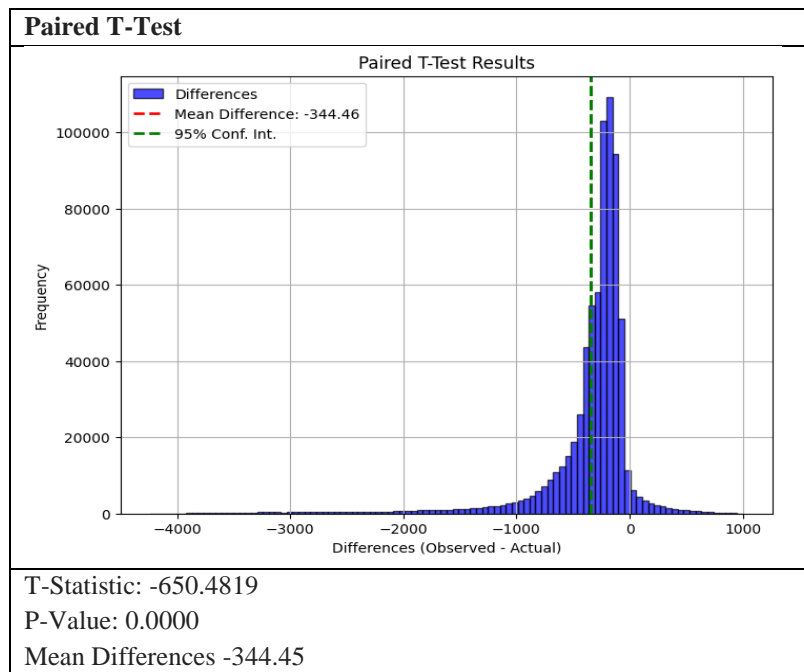
Figure 8: Statistical Test on E-commerce Weight and Actual Weight

Pareto Cause #3: Seller Not Input Product Dimension

This missing critical information in package estimation final weight on e-commerce platforms side, could lead to buyer paid less amount of shipping fee than the actual. This would be very impactful especially for volumetric based products, such as diapers, tissue, etc. One example shown on Figure **8**, product is diapers which have weight 3.3 kg, based on seller information. But, after fulfillment center remeasured the product, it has dimension 37800 cm3, which if converted to kg is 6.3 kg.

Which on this during this failure impact on IDR 2.9 billion from Q1-Q3 2023. Pareto conducted and shown that on **Error! Reference source not found.**, around 2.3 billion of these coming from 38 seller and 37 of them damage percentile 50 above of median distribution. However, Seller is stakeholder who support e-commerce assortment variety, but on this case, these 38 sellers has consistently affected loss to the company, then company need to hyper care these type of seller in order to have better governance on product listing and creation and give more accurate about the product weight and dimension.

Pareto Cause #4: Packer Failed to Follow Instructions

As Fulfillment Center has several standard packaging types, it should be tested whether is there any packaging type that packer has tendencies to assign with other packaging type, which leads to packaging size-up. It can be chi-squared test performed to show is there any significant association between packaging type and size-up from packer.

The chi-squared test helps to determine whether there is a notable difference between the normal frequencies and the observed frequencies in one or more classes or categories. It gives the probability of independent variables.

The null hypothesis is there is no significant association between packaging type and size-up from packer, while the alternative hypothesis is reject the null hypothesis shown on **Error! Reference source not found.**.

Chi Square Test
H_0 There is no significant association between packaging type and size-up from packer.
H_1 There is a significant association between packaging type and size-up from packer.

Chi-squared statistic: 282584.32

p-value: 0.0

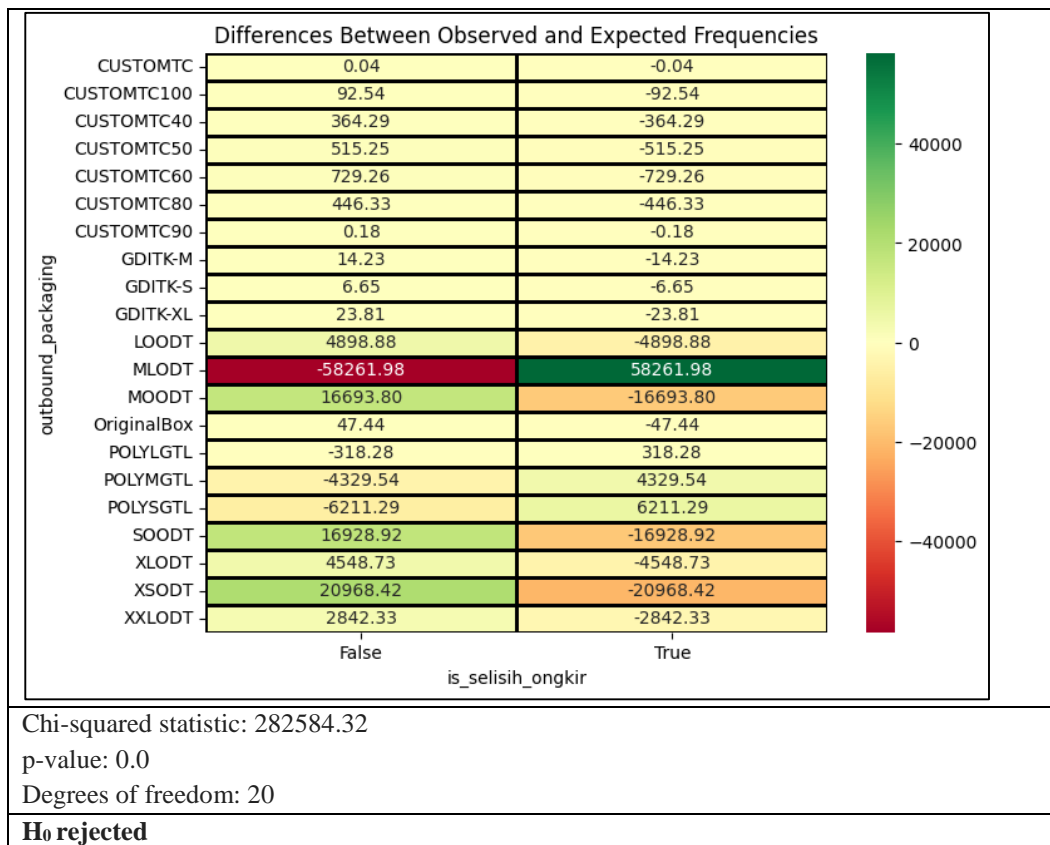Degrees of freedom: 20

H₀ rejected

Figure 9: Chi Square Test on Association between Packaging Type versus Size Up

Based on chi-squared test, it shows there is one packaging type that has tendencies the packer choose instead of packaging recommender on WMS, which is MLODT. If we look back on packaging type dimensions and considering that packaging recommendations use heuristic FFD algorithms. There is a big gaps between MOODT and MLODT about 700 g.

Packaging Type	cm			cm³	gr	kg
	Width	Length	Height	Volume	In Par	Final
…	…	…	…	…	…	…
MOODT	21	28	10	5,880	980	1
MLODT	23	33	13	9,867	1,645	2
…	…	…	…	…	…	…

So if the products has 1.200 grams in volumetrics weight, it will not fit in MOODT, instead packer will use MLODT which landed in 2 kg(s) bracket, while customer only paid for 1kg of shipping cost. So, it can conclude that because of bad design on packaging volume arrangement, packer has tendencies to change the packaging.

BUSINESS SOLUTIONS

Based on problem analysis on previous sub-chapter, the basics events were mapped in to root cause and solutions formulations. Accordingly, gap analysis phase will be done to list of solutions formulations to give a better improvement by comparing with best practices. However, the impact also measured and ordered from the biggest to the least to give visibility on what impact should be prioritize as shown below.

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ID	FTA Basics Event	Impact (IDR mio)	Root Cause	ID	Solutions
P1	Wasted Space on Packaging	3.681	Big product more than 1 kg have tendencies to shipping fee revenue leakage. Because packaging type volume not aligned with bracketed weight in ordinal number.	S1	**Operations** – need to revamp the packaging type based on bracket weight.
P2	Error in package weigh-in	3.129	Additional component such as bubble wrap and shredded paper weight was not yet considered in e-commerce platform.	S2	**Technology** – need to add the 300 grams additional as contingency as additional weight
P3	Seller Not Input Product Dimension	2.964	On e-commerce platform still not mandatory to input the dimension of the product. Seller which has volumetric product will impact the most to the revenue leakage. There is no integration between WMS and e-commerce platform about product weight and dimension data.	S3	**Technology** – e-commerce platform should be able to put volume as product creation mandatory.
				S4	**Technology** – there should be integration between WMS and e-commerce platform to push WMS measured weight and dimension to e-commerce platform.
P4	Packer Failed to Follow Instructions	2.526	There is a tendency from packaging type that packer size-up the packaging.	S1	**Operations** – need to revamp the packaging type based on bracket weight.

Figure 10: Root Cause Analysis Based on Fault Tree Analysis

Effort impact analysis conducted by measuring impact from previous impact on monetary breakdown analysis referring to root cause analysis below, while the effort conducted by stakeholders' interview to measure what need to be done if those solutions implemented.

ID	Solutions	Need to be Done	Impact (IDR mio)	Impact (1-5)	Effort (1-5)
S1	**Operations** – need to revamp the packaging type based on bracket weight.	Procurement needs to recalculate the cost of packaging and renegotiate with packaging vendor.	3.681 + 2.526 = 6.207	5	4
S2	**Technology** – need to add the 300 grams additional as contingency as additional weight	Tech team need to make additional feature and added to priority sprint. While product managers need to assess A/B testing regarding buyer experience.	3.129	4	1
S3	**Technology** – e-commerce platform should be able to put volume as product creation mandatory.	Tech team need to change feature on product creation page.	2.964 / 2 = 1.482	3	1
S4	**Technology** – there should be integration between WMS and e-commerce platform to push WMS measured weight and dimension to e-commerce platform.	Tech team and product managers from both side should be coordinate to make an integration planning to make database bridge between WMS and e-commerce platform.	2.964 / 2 = 1.482	3	2

Figure 11: Effort Impact Assessment

Based on proposed effort impact analysis, it can be plotted on effort impact matrix above and could be reference for management to be implemented in strategic initiatives. While the sequence of solutions implementation could be proposed as based on effort-impact matrix theory as shown below.
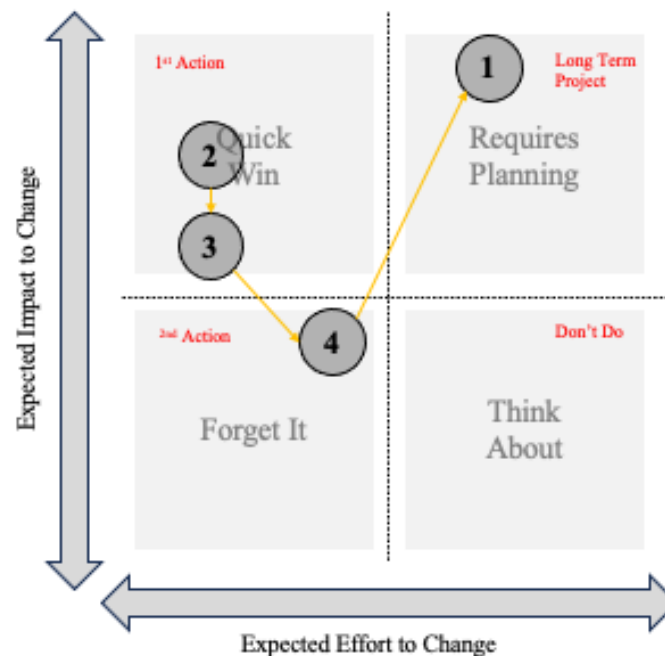

Figure 12: Proposed Effort Impact Matrix

Changes of the influences that will bring a relatively high effect and the implementation of which is relatively simple (low effort) are in quadrant "first actions". Thus, it should be possible to implement influences in this quadrant immediately. Changes with a smaller benefit, but still relatively simple, should be implemented next—these are in quadrant "second actions". Long-term projects, requiring relatively high effort, but also bringing the required effect are in quadrant "Long-term actions (projects)". It is not very rational to change influences in the quadrant "Don't do it" as efforts are high, and the effect is relatively small (Madzík & Chocholáková, 2018).

CONCLUSION

This research has already explored problem analysis and proposed solutions for shipping fee revenue leakage in delivery business in GL. At the current state process quality shows that sigma level is on level 2.47 which eaten up Rp 14.96 billion of delivery services revenue in Q1 to Q3 2023. Based on Fault Tree Analysis (FTA), revealed that shipping fee leakage could be breakdown into six failure events, which are system integration error, seller input wrong weight, seller not input product dimension, error in package weigh-in, packer failed to follow instruction, and wasted space on packaging.

Based on those failure events, four root causes of them contribute to 82.2% of revenue leakage, which are wasted space on packaging, error in package weigh-in, seller not input product dimension, and packer failed to follow instruction. After deep dive to the root cause, it could be tackled by four initiatives:

1. Operations – need to revamp the packaging type based on bracket weight.
2. Technology – need to add the 300 grams additional as contingency weight in e-commerce platform.
3. Technology – e-commerce platform should be able to put dimension as product creation mandatory.
4. Technology – there should be integration between WMS and e-commerce platform to push WMS measured weight and dimension to e-commerce platform.

Those initiative measured by effort and impact in 1 to 5 scaling and plotted into effort-impact matrix. The prioritize solution that should be implemented is starts from solution two and solution three, since its on quick wins diagram, after that solution four, and finally solution one, which take a lot of resources.

From set of solutions on effort impact effort matrix, it could be simulate the impact from process quality and monetary value effect as shown below.
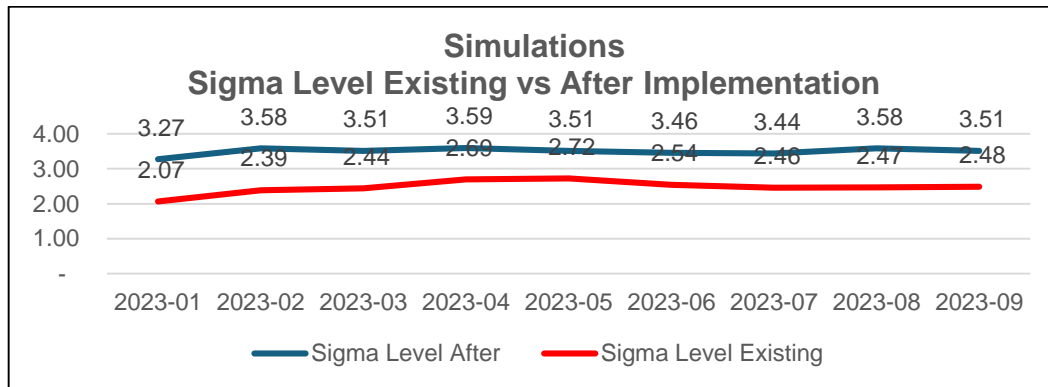

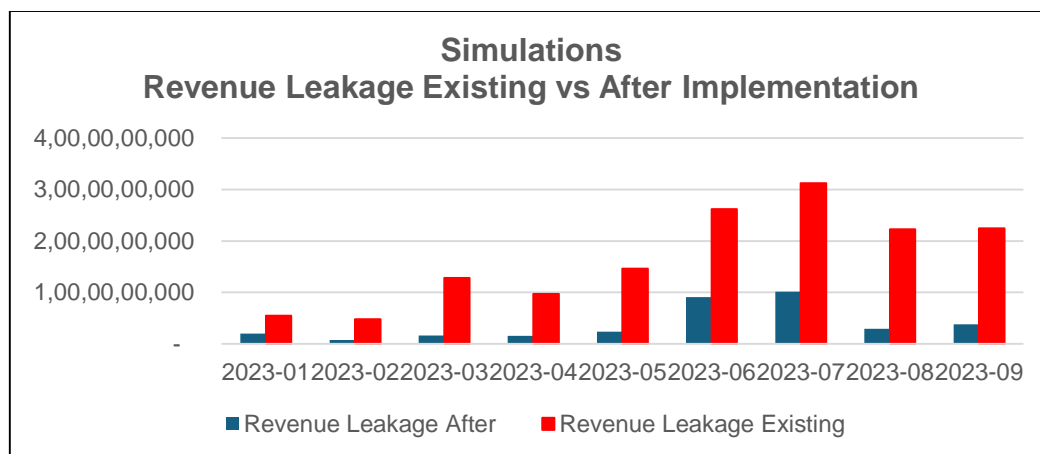
Figure 13: Simulations Sigma Level

Figure 14: Simulations Revenue Leakage

However, this study was not without its limitations. The research focused solely on internal operations, there should be post-hoc research that also measured on what impact on buyer side, which that plays vital role on demand creation.

In conclusion, this research shows that if company willing to reengineering its process it could be leads to process quality excellence and in the end it could be prevent the loss in monetary value.

RECOMMENDATION

Based on conclusions, some recommendations for GAJAH LOGISTICS delivery business as follows

1. **Improve Process Quality**: GAJAH LOGISTICS should focus on improving their process quality by have kaizen mindset to have improvement on day-to-day basis. As logistics company, efficiency should be number one in order to be number one in the market.
2. **Build Process Driven Culture:** As logistics companies, process excellence must be in number one priority, even though one process could be streamlined from several entities.
3. **Scaling Up on Technologies:** Technology on integration could be the most critical parts that plays in logistics process. Considering the main captive market e-commerce, its supporting logistics must be also faster.

4. **Management Dashboard as Controller:** Management dashboard will give visibility if the stakeholders has already implement the improvements initiative. By this, stakeholders also can have the insight if the solutions need to be enhanced.

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