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Profit Maximization Through Customer Profitability Management Using Whale Curve and Time-Driven Activity Based Costing

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Abstract
This study aims to formulate a profit maximization strategy for an offset printing company by integrating Customer Profitability Management (CPM) through Whale Curve Analysis and Time-Driven Activity-Based Costing (TDABC). The research was conducted as a quantitative case study at one of offset printing company in Indonesia, focusing on the food packaging segment comprising 147 customers. Whale Curve Analysis was used to map customer profitability distribution, while TDABC was applied to calculate more accurate production costs by considering time-based capacity rates. The results show that 20.41% of customers contribute 58.39% of the total contribution margin, 59.86% are at break-even, and 19.73% are less profitable. The TDABC analysis revealed a production cost reduction of IDR 266,234,623 compared to the company's traditional costing method, indicating previous overcosting and undercosting practices. The integration of Whale Curve and TDABC enabled the identification of profitable, break-even, and unprofitable customers and guided the development of differentiated strategies to retain, improve, or transform them. The study concludes that applying TDABC enhances cost accuracy and efficiency, while Whale Curve Analysis provides a clearer understanding of customer profitability—together leading to improved decision-making, competitive pricing, and overall profit maximization in the printing industry.

Keywords: *Profit Maximization, Customer Profitability Management, Whale Curve, Time-Driven Activity Based Costing*

1. Introduction

A company engaged in the printing industry is a type of manufacturing company that processes raw materials such as paper or other printing substrates into finished products, including packaging boxes, books, calendars, magazines, banners, leaflets, brochures, and other printed materials. The production growth of the manufacturing industry in the third quarter of 2023 for the printing and reproduction of recorded media sector increased by 14.23% compared to the previous period[1].This growth was also accompanied by increasing competition among printing companies due to the entry of more new players into the market. The Indonesian printing industry has been developing rapidly and contributes significantly to building the country's economic structure[2]. In addition, the printing industry is also considered one of the primary needs of every human being [3]

The offset printing industry faces both challenges and opportunities in adopting and implementing new technologies, namely the internet and digitalization[4]. Although technological developments have led to the digitalization of most offset print products such as books, magazines, and other reading media, offset printing still has another market segment with very high demand potential, namely the packaging segment. The positive growth of the offset printing industry is also reflected in the promising outlook of the pulp and paper industry in 2024. The favorable growth prospects of the paper industry are driven by increasing demand for paper from both domestic and international markets[5]. The growth of the paper industry also indicates that domestic paper needs are rising.

Amid the phenomenon of digitalization, which has had a highly significant impact on the offset printing industry, company management needs to make changes in business strategy[6]. Most offset printing companies certainly have a product segment in packaging. In 2024, the Indonesia Packaging Federation

(IPF) predicted that packaging volume growth in Indonesia would be in the range of 3%–4%[7]. The increasing potential demand for printed packaging can become the main focus for offset printing companies to optimize and take advantage of existing opportunities. Offset printing management can place greater emphasis on strengthening the packaging segment, particularly in terms of restructuring it to generate higher profits for the company.

The main objective of almost all companies is to maximize profit[8]. One of the steps companies can take to achieve this goal is by ensuring that their performance reaches an optimum and profitable level. To accomplish this, companies must employ various techniques, including increasing profits, reducing costs, creating economies of scale, maintaining price elasticity, managing risks, generating new ideas, and monitoring competition[8]. Optimizing company performance can also be done by creating new product lines, developing new products, conducting new pricing analyses, introducing marketing innovations, launching new service innovations, and developing other company potentials that are expected to accelerate the achievement of the company's primary objective[9]. However, all these steps must begin with implementing Customer Profitability Management (CPM), which is a strategy for identifying the relative profitability of various customer segments[10].

In some cases, management is often surprised to discover that only a small percentage of customers generate more than 100% of the profits, while other customers either break even or are unprofitable. Generally, companies that know which customers are more profitable and which are actually loss-making can be said to have more adequate and valuable information, as such data is essential for improving company performance and creating a domino effect on profit maximization[11]. The results of customer data analysis are highly useful for managers in planning and making better managerial decisions in terms of company profitability[12],[13],[14]. This customer data can be obtained by management through Whale Curve Analysis as an initial step in implementing CPM. Whale Curve Analysis presents a cumulative view of customer profitability, which helps enhance management's understanding of how profits are generated and lost across the customer base—and to what extent profitable customers subsidize unprofitable ones[15].

The main challenge in implementing CPM lies in the selection and application of a cost calculation system that is both accurate and informative[10]. Cost accuracy and visibility are crucial in CPM. Therefore, companies must ensure that the implementation of CPM is accompanied by the selection of a costing method that aligns with the company's characteristics. If Whale Curve Analysis is considered the initial step in implementing CPM, then the use of an appropriate costing method within the company serves as the backbone of CPM implementation. Conversely, if the costing method applied by the company is inaccurate and its visibility does not fit the company's characteristics, the implementation of CPM will be difficult to achieve.

At present, most printing companies in Indonesia have begun adopting computer-to-press technology in the form of direct imaging (using masters) and computer-to-print (without masters), which largely relies on digital printing machines[16]. Moreover, large and advanced printing companies have equipped their facilities not only for pre-press but also for finishing processes such as cutting, binding, folding, stitching, embossing, and others. This factor has contributed to the shift from conventional production cost calculation methods to more contemporary methods, currently known as Activity-Based Costing (ABC)[17]. Consequently, the calculation of the cost of goods manufactured (COGM) in printing companies requires a wide range of components and is relatively complex. Beyond the ABC method, determining the COGM in printing companies requires calculations that are more relevant to the company's characteristics.

The large number of machines involved in printing production processes introduces more time-related factors that significantly affect production costs. Therefore, addressing the problem of production cost calculation in printing companies becomes more relevant when using the Time-Driven Activity-Based Costing (TDABC) method. In his research, [11] reinforced that the TDABC costing method is particularly suitable for packaging manufacturers (printing packaging companies) where customer profitability analysis is conducted, given the presence of several policy complexities such as (1) made-to-order products, (2) special delivery arrangements, and (3) special pricing for certain customers. Barros and Ferreira (2017), in their study, also discussed that such complexities are the main drivers for the shift in cost accounting methods—from ABC to TDABC. Similarly, TDABC is more suitable for companies operating in situations where capacity utilization and cost structures are highly dynamic[18].

In addition, TDABC is considered a potential solution for profitability analysis, particularly in industries with high overhead costs and large-scale logistics or sales transactions, as it addresses the

shortcomings of the ABC model, which is often costly[11]. However, the use of a TDABC system introduces another challenge in determining the weight of different tasks with varying costs. The TDABC system considers the time spent by workers during production as the primary cost driver[19].

2. Statement of the Problem

As CPM strategy formulated through Whale Curve (WC) analysis and the TDABC costing method as previously described, customer data from offset printing companies will first be analyzed in the packaging segment using WC analysis. The results of this analysis will then be oriented toward developing strategies to cut the "tail" of the WC, which consists of profit takers or unprofitable customers. In other words, the aim is to formulate strategies to turn unprofitable customers into profitable ones. In addition, the strategy formulation should also be designed to provide value added to the most profitable customers and to make less profitable customers more profitable by refining the costing method using TDABC. After demonstrating the cost calculation with TDABC, the optimal profit margin range for product pricing will be determined. These two components will play a crucial role in supporting the overall strategy formulation.

Based on the background description above, printing companies must immediately focus on developing the packaging product segment by transforming their customer data analysis system and cost calculation system to be more relevant to the company's characteristics. This will have a significant impact on formulating corporate strategies to maximize profitability and strengthen competitiveness amid the ongoing growth of the printing industry. This study is therefore positioned to examine on how the customer's distribution of offset printing companies carried out based on Customer Profitability Management using Whale Curve Analysis is and how the relevant production cost calculation analyzed in offset printing companies using Time-Driven Activity-Based Costing conducted. Without a clear understanding of which customers generate profit or losses for the company and why, management strategies may lead the company in a highly unfavorable direction, as managerial decisions would be made without a solid consideration[11].

3. Research Question

How is the customer mapping of offset printing companies carried out based on Customer Profitability Management using Whale Curve Analysis? How is the relevant production cost calculation analyzed in offset printing companies using Time-Driven Activity-Based Costing? How is the strategy formulation arranged based on Whale Curve and Time-Driven Activity Based Costing?

4. Significance of the Study

This study integrates two disciplines, namely (1) management, represented by Customer Profitability Management (CPM) and Whale Curve (WC), and (2) accounting, represented by the Time-Driven Activity-Based Costing (TDABC) method for calculating the cost of goods manufactured. The integration of these two disciplines is expected to provide new insights for experts, showing that the two disciplines and the three concepts are in fact interrelated. In addition, this study is expected to contribute new knowledge for academics in integrating these two disciplines.

Customer Profitability Management (CPM) and Whale Curve (WC) are able to represent the distribution of a company's customer data as highly essential information for strategic decision-making. Furthermore, the TDABC method also represents a more relevant cost calculation approach for companies with relatively complex business processes. This study produces a profit maximization strategy based on CPM, WC, and TDABC. The findings of this study are expected to provide insights into formulating profit maximization strategies using these three concepts to enhance the competitiveness and profitability of companies.

5. Theoretical Framework

This study was guided by Profit Maximation Theory developed by Alfred Marshall which is one of the classical economic theories that states the primary objective of a company is to maximize profit. This theory underlies many economic and managerial decisions within companies. Profitability is a company's ability to generate profit[20]. On the other hand, [21] define profitability as the achievement of a company's economic success, obtained after covering all costs directly associated with revenues. Profitability maximization is the main goal of every company[22].

When it comes to maximizing profit, there are only two ways to achieve it[23]. Management can either reduce expenses (also referred to as costs) or increase sales (also referred to as revenue). However, both approaches are not easily attainable. Sales can be increased by selling more products or by raising product prices [24]. Selling more products is challenging due to market competition, and generally companies cannot raise prices without adding more features or value to the products sold (assuming a competitive market). Thus, actions that increase profits must be pursued, and actions that reduce profits must be avoided. In certain operational terms, as applied in financial management, all of a company's operational activities should be oriented toward profit maximization.

6. Literature Review

Customer Profitability Management

CPM is a strategy for identifying the relative profitability of various customers or customer segments in order to design strategies that provide added value to the most profitable customers, make less profitable customers more profitable, stop or reduce profit erosion by unprofitable customers, or alternatively focus on long-term customer profitability[10]. The implementation of CPM can be carried out in several ways that are closely related to customer accounting. Customer accounting can be defined as the process by which economic information about customers is identified, measured, interpreted, and communicated[25]. The main objective of customer accounting is to calculate and analyze the profit, revenue, and costs generated by specific customers or groups of customers[26],[27].

Customer accounting covers both retrospective (or historical) and prospective (or future) dimensions [28], each of which is operationalized through two main tools: CPA (Customer Profitability Analysis) and Lifetime Customer Profitability (LCP) analysis. This study will use CPA, or customer analysis, which applies the retrospective or historical dimension. CPA is the difference between the revenue earned and the costs associated with a customer's purchases during a given period[29]. Thus, CPA is a retrospective analysis of customer profitability and involves the allocation of revenue and costs to customer segments or individual customers, so that the profitability of those segments and/or individual customers can be calculated[14].

CPA approach carried out from a "pocket margin" perspective, which calculates the profitability of each transaction by subtracting all related costs within a single transaction [30]. In reality, product costs do not only come from raw materials or the cost of sales. These costs may also arise from invoice discounts and promotions, as well as other less obvious expenses such as transportation, shipping, storage, and other activities that can be classified as "overhead costs." The graphical construction of a "price waterfall," which illustrates the progression of price reductions from gross sales down to the "pocket margin" is also provided. The pocket margin can be understood as the actual profit margin received by the company after deducting all of the aforementioned costs, including cost-to-serve. Unfortunately, the analysis should ideally stop at the contribution margin, since no relevant method has yet been found for allocating corporate administrative costs[31].

Whale Curve

One of the data visualizations that can be used for profitability analysis is the "Whale Curve" so named because the curve resembles the back of a whale. The Whale Curve (WC) effectively visualizes which customers are profitable for the business, which are at break-even, and which are unprofitable[32]. WC is a very simple yet effective line chart that illustrates the percentage of cumulative profit on the y-axis and the percentage of customers ranked by profitability (from highest to lowest) on the x-axis [33]. The WC visualization provides a quick and easy-to-understand picture of customer profitability. It helps management simplify profitability reporting, as they can immediately see which customers are profitable without having to spend hours analyzing thousands of rows in a spreadsheet[32].

The Whale Curve graph depicts 100% of profit, where the Y-axis represents profit in the chosen currency unit or as a percentage of profit from all customers, and the X-axis represents cumulative customers or customer segments ranked from high to low as a proxy for profitability. In most cases, about 20% of customers generate 150% to 300% of the company's profit, around 70% of customers are at break-even or maintain profit, and 10% of customers actually reduce or destroy 50% to 200% of the company's profit[34]. In more detail, profitable customers represent the top 20% of the company's customers who generate 180% of overall profitability, as shown on the left side of the WC. These customers provide the highest profit margins for the company; therefore, any future business decisions must consider this client

base, as ignoring them could reduce the company's profitability. Break-even customers consist of 60% of customers who reach the break-even point in terms of profitability. The revenue generated by these customers is offset by the costs incurred to serve them, so they can be considered customers who sustain the company's profitability. On the right side of the WC, the unprofitable customers represent the bottom 20% of customers, who are responsible for reducing overall profitability by 80% until it reaches the final realization of 100%. Company management must examine this list of customers to understand why they reduce the firm's profitability.

Time-Driven Activity Based Costing

Time-Driven Activity-Based Costing (TDABC) can be considered a costing method that improves upon its predecessor, Activity-Based Costing (ABC)[35]. TDABC refines the ABC method by simplifying the implementation of the ABC calculation process, which is often too time-consuming and requires costly maintenance, as originally designed by Kaplan and Anderson[36]. Several shortcomings of the ABC method identified in prior studies include: (1) ABC requires too much data to implement the model[18], where employees must regularly complete surveys about the time they spend on each activity. These surveys are time-consuming and costly[36],[37],[38], (2) In such surveys, employees must provide subjective estimates of the time they devote to activities, and this subjectivity creates doubts about data accuracy [36],[37], (3) Although most activities involve assumptions, the ABC calculation model is not sufficiently accurate to capture the complexity of the company's daily operations [36]. (4) Because ABC cannot adequately reflect such complexity, adding more activities to the model makes the ABC model increasingly complex[39]. Thus, the TDABC model was developed as an alternative and solution to the ABC model, without abandoning the core concept of ABC.

The alternative TDABC model does not require extensive and recurring employee surveys, making cost calculation easier, more accurate, and less expensive[40]. This new model directs general ledger costs directly to departments, unlike ABC, which channels general ledger costs to hundreds of activities[41]In addition, TDABC directly allocates resource costs to cost centers using two easily obtainable parameters for each resource group: (1) Capacity Cost Rate (CCR), and (2) Time required to complete a transaction or activity [36],[42],[43],[35][41]. CCR is the ratio between the cost of capacity supplied and the practical capacity of the resources supplied, as shown in the following equation:

$$\text{Capacity Cost Rate (CCR)} = \frac{\text{Cost of capacity supplied (CCS)}}{\text{Practical capacity of the resources supplied (PCRS)}}$$

The first parameter, Capacity Cost Rate (CCR), contains the numerator, namely the *cost of capacity supplied*, which refers to the resources used to carry out an activity, while the denominator of the equation is the practical capacity of the resources supplied—that is, the estimated time actually spent by employees performing their activities with the available resources in a specific cost center[43],[44]. It is important to emphasize that PCRS is not the total time allocated to perform a given activity, but rather the actual amount of time employees truly spend on their activities. In the ABC model, resource capacity is always assumed to be at full capacity. However, in empirical reality, there are situations where time is used unproductively. Therefore, in the TDABC model, the term practical capacity refers to the productive time of employees or machines in performing activities, whereas unpractical capacity refers to the non-productive time of employees or machines. The practical capacity of resources does not include the time employees spend on activities such as resting or taking breaks unrelated to actual performance or activities[45]. In their discussion, the term of theoretical capacity (TC) is introduced to refer to the total time provided by the company to perform certain activities[36], which is generally formulated as follows:

$$\text{PC} = \text{Theoretical Capacity} - \text{Non Practical Capacity}$$

Non-practical capacity is generally assumed by companies. In the study by Barros and Ferreira, the company under study used an assumption of 20% non-practical capacity[35], while in the research by Adiguzel and Floros the company under study used an assumption of 15%[41].

The second parameter is determining the time required by employees or machines to perform one unit of each type of activity[46], which can be obtained through direct observation, asking staff or management teams, or analyzing the company's historical data[36],[40]. Once both parameters are determined, they must be multiplied to assign costs to cost objects[36],[40]. This multiplication represents the simplest form of a time equation and is referred to as the **cost-driver rate**. This equation introduces a novel approach when compared to ABC, as the TDABC model allows for the reflection of various characteristics of activities and

generates variations in the time spent by employees or machines. This means that TDABC is more capable of capturing the complexities present within the company. Such complexities are captured through the time equation with a smaller and more flexible model because its size increases only linearly with complexity, whereas in the ABC model, its size increases exponentially[36],[40].

The TDABC model also does not require periodic updates, making it much easier to implement[36]. Furthermore, one of the reasons TDABC is less time-consuming and more cost-effective than the ABC model is that, with the help of the TDABC time equation, the time required to perform an activity can be estimated without the need for continuous interviews or surveys of employees. The TDABC approach with its time equation also allows for precise knowledge of how many minutes or hours employees spend on their activities[45]. Based on the explanation, the main difference between ABC and TDABC lies in cost allocation: ABC allocates costs using several activity factors, whereas TDABC relies on just one factor—time[47],[48].

7. Research Gap

Previous studies that form the basis of this research are grounded in findings indicating that the Time-Driven Activity-Based Costing (TDABC) method is more suitable for application in manufacturing companies with complex business characteristics and relatively intricate production processes[35],[48],[41]. In addition, other studies have found that Customer Profitability Management is closely related to Customer Profitability Analysis, which employs the Whale Curve as an analytical tool. The key to implementing Customer Profitability Management (CPM) lies in the selection and implementation of an accurate and informative costing system[10]. The Time-Driven Activity-Based Costing (TDABC) system is considered more relevant for use in manufacturing companies. The application of the TDABC costing system also supports the implementation of CPM, which is based on the characteristics of the company and its customers[11]. Based on these findings, previous studies have largely focused on discussing CPM–Whale Curve, TDABC, or the elaboration of both concepts, without providing strategic recommendations. Therefore, the research novelty or research gap of this study lies in the development of strategic recommendations formulated based on the company's condition as represented by the Whale Curve and TDABC, with the aim of maximizing the company's contribution margin or profit.

8. Research Methodology

This research is a quantitative and case study with a descriptive approach. The study was conducted at CV. Megah Offset Mandiri (MOM) in Jember, East Java. MOM produces food packaging boxes as well as other printing products (such as books, calendars, magazines, labels, pamphlets, posters, and more) with a customer base across East Java. The unit analysis of the research is the food packaging boxes due the products segment has shown significant sales growth over the past two years. There were 147 customers of food packaging in year 2024 analyzed in this research. The research used primary data that were collected from the company documentation, such as sales record, production process record, and financial statements in 2024. Also, data related to the measurement of activity times was taken by direct observation and interview with the managers.

The data analysis was conducted by Whale Curve Analysis and Time-Driven Activity-Based Costing (TDABC). The Whale Curve Analysis aims to identify the customer profitability distribution. The analysis followed the procedure of Laussermair consisting of (1) gathering customer revenue and cost data, (2) calculating profit per customer, (3) sorting the customers from most to least profitable, (4) computing cumulative profit, and (5) plotting cumulative profit against the cumulative percentage of customers. The analysis resulted in a curve representing the percentage of customers (from least profitable to most profitable) and represents cumulative profit[33]. TDABC is conducted to allocate the overhead and consumable costs based on activity time to the product cost. Following Ganorkar, the procedure of TDABC consisted of (1) identifying the entire sequence of activities in production, (2) measuring the activity time of every activity and calculating the practical capacity of the activity (i.e. the ratio of the total time consumed by an activity for the products to the quantity of products produced), (3) calculating cost driver rates for overheads and consumables, and (4) allocating activity costs to products using time equations. The output of TDABC is the product cost reflecting the actual resource consumption[48].

9. Findings and Discussion

General Overview of the Research Object

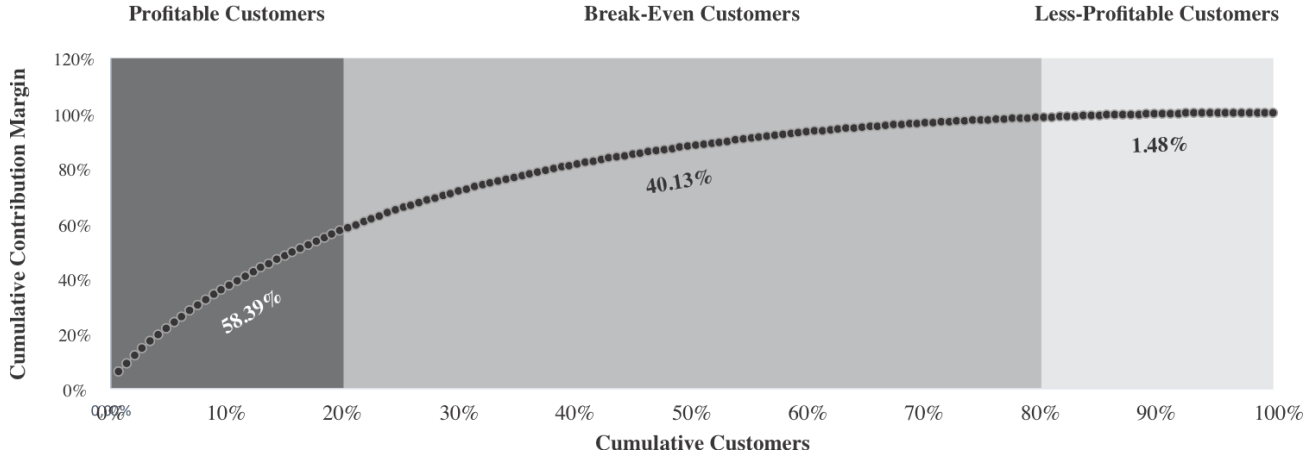
CV. Megah Offset Mandiri (MOM) is a company engaged in the offset printing industry, located in Jember, East Java. Based on the company's internal reports from 2023 to 2024, the company's revenue composition has become increasingly dominated by the food packaging product segment. In 2024, this segment comprised 147 customers with varying business scales and legal forms, ranging from individual enterprises and trading entities (UD) to limited partnerships (CV). Over the course of one year, these 147 customers generated 1,005 transactions, resulting in a total of 2,294,000 sheets of food packaging sold within the year.

MOM produces 18 types of food packaging, categorized according to code, type, material, and lamination type. There are three types of packaging, namely Lunchbox L, Squarebox L, and Squarebox XL. Each type has a specific size range predetermined by the company. The packaging materials are divided into two categories, namely Duplex and Ivory, with varying thicknesses of 250 gsm, 300 gsm, 310 gsm, and 400 gsm. There are three types of laminating, namely non-laminated packaging, single-sided laminating (laminated only on the outer or inner surface), and double-sided laminating (laminated on both surfaces).

Result of Whale Curve Analysis

Whale Curve analysis is carried out based on steps previously described. Sales data and cost data collected for each type of food packaging, obtained from the company's internal reports, are the data set required for the Whale Curve Analysis. The principle of constructing the Whale Curve graph requires that customers be grouped on an individual basis. After the total contribution margin value is determined, customer groups are ranked from the most profitable to the least profitable. The Whale Curve graph is constructed based on the cumulative share of total contribution margin plotted against the cumulative share of customers, where the horizontal axis represents the percentage of customers and the vertical axis represents the cumulative contribution margin (cumulative share of total contribution margin). Based on Figure 1, the Whale Curve of CV. MOM in the food packaging sector shows that: (1) The top 20.41% of customers contribute 58.39% of the total contribution margin, (2) 59.86% of customers contribute 40.13% of the total contribution margin (3) The bottom 15.65% of customers contribute only 1.61% of the total contribution margin. (4) Meanwhile, 4.08% of customers cause a loss of 0.13%.

Figure 1. Whale Curve



Source: Data processed by the researchers, 2025

The classification of customers based on their contribution margin levels is shown in Figure 1 and Table 1. Customers are divided into three categories, namely profitable customers, break-even customers, and less profitable customers. The profitable customers consist of 30 customers who generate a contribution margin of Rp 594,109,982. The break-even customers include 88 customers who generate a contribution margin of Rp 408,317,067, while the less profitable customers consist of 29 customers who generate a contribution margin of only Rp 15,058,790.

Table 1. Group of Customers based on Contribution Margin

Category	Group of Customers	Number of Customers	Contribution Margin
1	Profitable Customers	30 (20.41%)	Rp 594,109,982

2	Break-Even Customers	88 (59.86%)	Rp 408,317,067
3	Less Profitable Customers	29 (19.73%)	Rp 15,058,790

Source: Data processed by the researchers, 2025

Result of Time-Driven Activity Based Costing

The TDABC calculation is based on the principle that each activity within a department requires varying amounts of time to complete the production process. Therefore, TDABC employs time equations in its analytical calculations. Since the types of food packaging are divided into three categories—Lunchbox L (Lbox L), Squarebox L (Sbox L), and Squarebox XL (Sbox XL)—the processes of paper cutting, printing, lamination, and creasing require different amounts of time for each type. Consequently, the time equations in this calculation are divided into three separate equations, each corresponding to a specific packaging type. In addition, the order system for packaging is divided into three quantities per transaction, namely 1,000, 2,000, or 5,000 units, resulting in different additional time requirements for each type. For example, the cutting process for Lbox L requires 15 minutes for the first 1,000 sheets. If a customer orders 2,000 sheets per transaction, the first 1,000 sheets are calculated as 15 minutes, while the next 1,000 sheets require an additional 5 minutes. This principle similarly applies to the lamination and creasing processes. In the printing process, different machines are used for each type of packaging: Lbox L and Sbox XL are produced using the OLV66 machine, while Sbox L is produced using the OLV52 machine. The calculation of production time for each type of packaging follows the same approach as that applied to other departments.

The time equations for each type of packaging are illustrated in Figure 2. These time equations serve as the basis for the final calculation step in the TDABC analysis. In the time equation, the Capacity Cost Rate (CCR) functions as the value representing the resource capacity required to produce the packaging. The Employee CCR is derived from the calculation of employee capacity costs, which are subsequently used as direct labor costs. Meanwhile, the Activity CCR is obtained from the sum of the consumables CCR (representing expendable materials supporting each department's activities) and the overhead CCR (representing machinery used to support each department's activities).

Figure 2. Time Equation of Each Packaging Type

LBOX L

$$5 \text{ minutes} \times CCR_{(\text{Storage Employee})} + 5 \text{ minutes} \times CCR_{(\text{Storage Employee})} + 3 \text{ minutes} \times CCR_{(\text{Cutting Operator})}$$
$$+ 15 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Cutting Activity})} + 5 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Cutting Activity})}$$
$$+ 15 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Cutting Operator})} + 5 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Cutting Operator})}$$
$$+ 10 \text{ minutes} \times CCR_{(\text{Printing Operator})} + 5 \text{ minutes} \times CCR_{(\text{Printing Operator})} + 5 \text{ minutes} \times CCR_{(\text{Printing Operator})} + 480 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Printing Activity})}$$
$$+ 60 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Printing Activity})} + 480 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Printing Operator})}$$
$$+ 60 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Printing Operator})} + 5 \text{ minutes} \times CCR_{(\text{Laminating Operator})} + 5 \text{ minutes} \times CCR_{(\text{Laminating Operator})}$$
$$+ 45 \text{ minutes (per 1,000 sheets)} \times CCR_{(\text{Laminating Activity})} + 45 \text{ minutes (per 1,000 sheets)} \times CCR_{(\text{Laminating Operator})} + 5 \text{ minutes} \times CCR_{(\text{Creasing } \textit{Operator})}$$
$$+ 15 \text{ minutes} \times CCR_{(\text{Creasing } \textit{Operator})} + 60 \text{ minutes (per 1,000 sheets)} \times CCR_{(\text{Creasing } \textit{Activity})} + 60 \text{ minutes (per 1,000 sheets)} \times CCR_{(\text{Creasing } \textit{Operator})}$$
$$+ 25 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Quality Control and Packing Activity})} + 15 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Quality Control and Packing Activity})}$$
$$+ 25 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Quality Control and Packing Employee})} + 15 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Quality Control and Packing Employee})}$$

SBOX L

$$5 \text{ minutes} \times CCR_{(\text{Storage Employee})} + 5 \text{ minutes} \times CCR_{(\text{Storage Employee})} + 3 \text{ minutes} \times CCR_{(\text{Cutting Operator})}$$
$$+ 20 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Cutting Activity})} + 5 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Cutting Activity})}$$
$$+ 20 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Cutting Operator})} + 5 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Cutting Operator})}$$
$$+ 10 \text{ minutes} \times CCR_{(\text{Printing Operator})} + 5 \text{ minutes} \times CCR_{(\text{Printing Operator})} + 5 \text{ minutes} \times CCR_{(\text{Printing Operator})} + 420 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Printing Activity})}$$
$$+ 60 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Printing Activity})} + 420 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Printing Operator})}$$
$$+ 60 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Printing Operator})} + 5 \text{ minutes} \times CCR_{(\text{Laminating Operator})} + 5 \text{ minutes} \times CCR_{(\text{Laminating Operator})}$$
$$+ 60 \text{ minutes (per 1,000 sheets)} \times CCR_{(\text{Laminating Activity})} + 60 \text{ minutes (per 1,000 sheets)} \times CCR_{(\text{Laminating Operator})} + 5 \text{ minutes} \times CCR_{(\text{Creasing } \textit{Operator})}$$
$$+ 15 \text{ minutes} \times CCR_{(\text{Creasing } \textit{Operator})} + 75 \text{ minutes (per 1,000 sheets)} \times CCR_{(\text{Creasing } \textit{Activity})} + 75 \text{ minutes (per 1,000 sheets)} \times CCR_{(\text{Creasing } \textit{Operator})}$$
$$+ 25 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Quality Control and Packing Activity})} + 15 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Quality Control and Packing Activity})}$$
$$+ 25 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Quality Control and Packing Employee})} + 15 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Quality Control and Packing Employee})}$$

SBOX XL

$$5 \text{ minutes} \times CCR_{(\text{Storage Employee})} + 5 \text{ minutes} \times CCR_{(\text{Storage Employee})} + 3 \text{ minutes} \times CCR_{(\text{Cutting Operator})}$$
$$+ 25 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Cutting Activity})} + 5 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Cutting Activity})}$$
$$+ 25 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Cutting Operator})} + 5 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Cutting Operator})}$$
$$+ 10 \text{ minutes} \times CCR_{(\text{Printing Operator})} + 5 \text{ minutes} \times CCR_{(\text{Printing Operator})} + 5 \text{ minutes} \times CCR_{(\text{Printing Operator})} + 480 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Printing Activity})}$$
$$+ 60 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Printing Activity})} + 480 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Printing Operator})}$$
$$+ 60 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Printing Operator})} + 5 \text{ minutes} \times CCR_{(\text{Laminating Operator})} + 5 \text{ minutes} \times CCR_{(\text{Laminating Operator})}$$
$$+ 60 \text{ minutes (per 1,000 sheets)} \times CCR_{(\text{Laminating Activity})} + 60 \text{ minutes (per 1,000 sheets)} \times CCR_{(\text{Laminating Operator})} + 5 \text{ minutes} \times CCR_{(\text{Creasing } Operator)}$$
$$+ 15 \text{ minutes} \times CCR_{(\text{Creasing } Operator)}) + 75 \text{ minutes (per 1,000 sheets)} \times CCR_{(\text{Creasing } Activity)} + 75 \text{ minutes (per 1,000 sheets)} \times CCR_{(\text{Creasing } Operator)}$$
$$+ 25 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Aktvitias QCP})} + 15 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Quality Control and Packing Activity})}$$
$$+ 25 \text{ minutes (for the first 1,000 sheets)} \times CCR_{(\text{Quality Control and Packing Employee})} + 15 \text{ minutes (for the next additional 1,000 sheets)} \times CCR_{(\text{Quality Control and Packing Employee})}$$

Source: Data processed by the researchers, 2025

In the next stage, the estimation of overhead supporting the activities is presented along with its costs and practical capacity values, referred to as Practical Capacity Overhead (PC_O). The practical capacity (PC_O) is calculated using the formula Theoretical Capacity Overhead (TC_O) minus Non-Practical Capacity Overhead (NPC_O).

TC_O in the context of overhead represents the maximum capacity of a machine to operate within a single working day, while from the perspective of employee working hours, it represents the amount of time provided by the company to perform specific activities. Therefore, the estimation of TC_O must first be conducted, with the NPCO estimated at 20%. This estimation is based on the study by Barros and Ferreira, which examined a manufacturing company using an NPC value of 20%, reflecting the complex business characteristics of the offset printing industry.

Based on Table 2, the TC_O (Theoretical Capacity Overhead) values are obtained by estimating the maximum operating capacity of each machine. This estimation must take into account the characteristics of the packaging products, which vary by type and order quantity. Therefore, the estimation of maximum capacity is based on the most frequently produced packaging type and the largest order volume per transaction, namely Sbox L with 5,000 units per order. Furthermore, the overhead capacity values presented represent annual capacity. In this calculation, one year consists of 293 working days, derived from 366 calendar days minus 48 Sundays and 25 national holidays and collective leave days. Each working day consists of 7 working hours, equivalent to 420 minutes, applicable to all machines except the printing machines. The printing machines and their operators work 14 hours per day (two shifts), equivalent to 840 minutes, and this applies equally to both printing machines.

Table 2. Practical Capacity of Overhead (PC_O) and Cost Driver Rate of Overhead (CR_O)

Overhead	*Cost Driver*	TC_O (100%)	NPC_O (20%)	PC_O (80%)	Depreciation Cost of Overhead (Rp)	Cost Driver Rate (CR_O)
Cutting Machine	sheets	11,609,434	2,321,887	9,287,547	135,675,000	Rp14.61/sheets
Printing Machine 52	sheets	1,809,275	361,855	1,447,420	145,250,000	Rp100.35/sheets
Printing Machine 66	sheets	1,662,775	332,555	1,330,220	157,650,000	Rp118.51/sheets
Laminating machine	sheets	1,984,782	396,956	1,587,826	82,475,000	Rp51.94/sheets
Creasing Machine	sheets	1,557,721	311,544	1,246,177	97,500,000	Rp78.24/sheets

Source: Data processed by the researchers, 2025

The TC_O estimation for the cutting machine follows the previously established maximum capacity conditions. It requires 13 minutes for setup, 20 minutes to cut the first 1,000 sheets, and 20 minutes (4 × 5 minutes) to cut the remaining 4,000 sheets. This time capacity is based on the time equation in Figure 2, derived from the machine's operating hours. Therefore, a total of 53 minutes is required to process 5,000 sheets, resulting in a daily TC_O of 39,662 sheets (420 minutes ÷ 53 minutes × 5,000 sheets). On an annual basis, the cutting machine's TC_O equals 11,609,434 sheets (39,662 sheets per day × 293 days).

The TC_O for the OLV52 printing machine differs from that of the OLV66 machine. The estimated TC_O for the OLV52 is calculated with an initial setup time of 20 minutes, 420 minutes to print the first 1,000 sheets, and 240 minutes (4 × 60 minutes) to print the remaining 4,000 sheets. Thus, a total of 680 minutes per day is required to print 5,000 sheets, resulting in a daily TC_O of 6,175 sheets (840 minutes ÷ 680 minutes × 5,000 sheets). On an annual basis, the TC_O for the OLV52 printing machine equals 1,809,275 sheets (6,175 sheets per day × 293 days). The TC_O for the OLV66 printing machine is calculated using the same principle as the OLV52. It requires 20 minutes for initial setup, 480 minutes to print the first 1,000 sheets, and 240 minutes (4 × 60 minutes) to print the remaining 4,000 sheets. Thus, a total of 740 minutes per day is needed to print 5,000 sheets, resulting in a daily TC_O of 5,675 sheets (840 minutes ÷ 740 minutes × 5,000 sheets). The annual TC_O for the OLV66 printing machine equals 1,662,775 sheets.

The TC_O calculations for the lamination and creasing machines do not have tiered time variations as seen in the printing machines. The lamination machine requires 310 minutes in total—10 minutes for setup and 300 minutes (5 × 60 minutes) to process 5,000 sheets. Therefore, its daily TC_O equals 6,774 sheets (420 ÷ 310 × 5,000 sheets), resulting in an annual TC_O of 1,984,782 sheets. Meanwhile, the creasing machine requires 395 minutes in total—20 minutes for setup and 375 minutes (5 × 75 minutes) to process 5,000 sheets. Thus, its daily TC_O equals 5,316 sheets (420 ÷ 395 × 5,000 sheets), producing an annual TC_O of 1,557,721 sheets.

Once all TC_O estimates are obtained, the PC_O (Practical Capacity Overhead) can be calculated by subtracting the NPC_O (Non-Practical Capacity Overhead) from the TC_O. Accordingly, the machine capacity calculations comply with the TDABC principle, which assumes that overhead operates at practical capacity rather than full capacity. The Cost Driver Rate of Overhead (CR_O) is then determined by dividing the overhead depreciation costs (as derived from the company's balance sheet) by the PC_O. Table 2 also presents the CR_O values for each overhead component.

The next analytical step after calculating the Cost Driver Rate of Overhead (CR_O) is to estimate the consumable materials that support production activities (Table 3). The Practical Capacity of Consumables (PC_C) is calculated by adjusting it to the total number of packaging units produced within one year. In other words, the PC_C is determined under the assumption that the inventory turnover of consumable materials aligns with production needs, or that the company applies an Economic Order Quantity (EOQ) system. This ensures that the stock of consumable materials is neither purchased in excessive quantities (overstock) nor in insufficient quantities (understock). The practical capacity of consumables is directly calculated by considering the machine characteristics that require consumable materials. For example, every 1,000 sheets of packaging require 500 watts of power for the cutting machine, 12,000 watts for the printing machine, 1,500 watts for the lamination machine, and 1,500 watts for the creasing machine. In addition, every 1,000 sheets of packaging consume 50 ml of oil in both the cutting and creasing machines.

Table 3. Practical Capacity of Consumables (PC_C) and Cost Driver Rate of Consumables (CR_C)

Consumables	Number of Sheets Produced (per 1.000)	Number of Consumables Needed per 1.000 (ml)	PCc	Consumables Cost (Rp)	Cost Driver Rate (CR_C)
Machine OIL	1,850	50	92,500 ml	14,522,500	Rp157/ml
Plate Cleaner	1,850	50	92,500 ml	2,275,000	Rp25/ml
Fountain Liquid	1,850	100	200,000 ml	5,100,000	Rp26/ml
Fuel Mixture	1,850	200	370,000 ml	8,140,000	Rp22/ml
Packing Paper	1,850	2	3,700 sheets	1,665,000	Rp450/sheet
Clear Tape	1,850	0.25	463 roll	2,720,125	Rp5,875/ roll
Electricity				41,325,000	Rp1.45/W

Source: Data processed by the researchers, 2025

CV. MOM produced a total of 2,294,000 sheets of food packaging in 2024. These packaging products are divided into three types: Lbox L with 1,026,000 sheets, Sbox L with 930,000 sheets, and Sbox XL with 338,000 sheets. It should be noted that Lbox L packaging has a different printing characteristic compared to Sbox L and Sbox XL. In each printing sheet during the production process, Lbox L contains two images (dual packaging images), while the other two types—Sbox L and Sbox XL—contain only one image per printing sheet. Therefore, the calculation of the Lbox L packaging capacity must be divided by two, as each

print run produces two packaging sheets at once. Consequently, the effective number of Lbox L sheets is 513,000 sheets. For the Practical Capacity of Overhead (PC_O) in the cutting machine, the capacity is calculated by summing all the sheets produced: 513,000 sheets of Lbox L, 930,000 sheets of Sbox L, and 338,000 sheets of Sbox XL, resulting in a total of 1,781,000 sheets processed by the machine. The stock position of consumable materials is assumed to be sufficient for 1,850,000 packaging sheets.

After the cost driver rates for overhead (PC_O) and consumables (PC_C) are determined, the next step in the analysis is to calculate the activity cost for each type of packaging. The activity cost is calculated by summing the overhead and consumables costs, each of which is obtained by multiplying the respective cost driver rate (overhead/consumables) by the practical capacity of the activity (overhead/consumables), as presented in Table 4 for Lbox L packaging. The practical capacity for overhead is calculated based on the number of packages produced for each type. For example, the production volume of 513,000 units of Lbox L packaging serves as the basis for calculating the practical capacity, which is then multiplied by the overhead cost driver rate for each machine. In this case, the laminating machine uses a different calculation method because not all Lbox L packages go through the lamination process. Therefore, the figure of 560,500 for the Lbox L packaging is derived from the number of packages that undergo single-sided lamination (354,500 units, after being divided per image) and double-sided lamination (206,000 units, after being divided per image and multiplied by two due to double-sided processing). The same calculation method also applies to the Sbox L and Sbox XL packaging types.

Table 4. Lbox L Activity Cost

Overhead/ Consumables	CRO/ CRC	Cutting		Printing		Laminating		Creasing		Packing	
		PCOA/ PCCA	CRO x PCOA (Rp) CRC x PCCA	PCOA/ PCCA	CRO x PCOA (Rp) CRC x PCCA	PCOA/ PCCA	CRO x PCOA (Rp) CRC x PCCA	PCOA/ PCCA	CRO x PCOA (Rp) CRC x PCCA	PCOA/ PCCA	CRO x PCOA (Rp) CRC x PCCA
	A	B	A x B	C	A x C	D	A x D	E	A x E	F	A x F
Cutting Machine	14.6	513,000	7,494,043								
OLV 66 Printing Machine	118.5			513,000	60,797,800						
OLV 52 Printing Machine	100.4										
Laminating Machine	51.9					560,500	29,113,548				
Creasing Machine	78.2							513,000	40,136,760		
Electricity	1.4	256,500	371,147	6,156,000	8,907,545	840,750	1,216,539	769,500	1,113,443		
Machine Oil	157	10,260	1,610,820	25,650	4,027,050						
Plate Cleaner	24.6			25,650	630,851						
Fountain Liquid	25.5			51,300	1,308,150						
Fuel Mixture	22			102,600	2,257,200						
Packing Paper	450									1,026	461,700
Clear Tape	5,875									128.25	753,468
Activity Cost (AC)			**9,476,010**		**7,7928,597**		**30,330,088**		**41,250,203**		**1,215,168**

Source: Data processed by the researchers, 2025

Where: CRO = *Cost Driver Rate (Overhead),* CRC = *Cost Driver Rate (Consumables),* PCOA = *Practical Capacity of Activity (Overhead),* PCCA = *Practical Capacity of Activity (Consumables),* AC = *Activity Cost*

Table 5. Practical Capacity of Direct Labor (PC_L) and Cost Driver Rate of Direct Labor (CR_L)

Direct Labor	Number of Employee	TC_L (100%) (minutes)	NPC_L (20%) (minutes)	PC_L (80%) (minutes)	Salary Cost (Rp)	CCR_L
Storage Employee	2	246,120	49,224	196,896	67,200,000	Rp341/min
Cutting Operator	1	123,060	24,612	98,448	36,000,000	Rp366/min
Printing Operator	4	580,140	116,028	464,112	173,300,000	Rp373/min
Laminating Operator	2	246,120	49,224	196,896	67,200,000	Rp341/min
Creasing Operator	2	246,120	49,224	196,896	67,200,000	Rp341/min
QC and Packing Employee	2	246,120	49,224	196,896	67,200,000	Rp341/min

Source: Data processed by the researchers, 2025

After the activity cost (AC) is determined, the next step is to calculate the capacity cost rate of direct labor (CCR_L) as displayed in Table 5. CCR_L is obtained by dividing the total cost (employee salary) by the practical capacity of direct labor (PC_L). PC_L is calculated by subtracting the total company-provided working hours (TC_L) from the non-productive capacity of labor (NPC_L). NPC_L is assumed to be the same as the non-productive capacity of the operator (NPC_O), which is 20%, since the machine is operated by an operator. TC_L is calculated by subtracting 48 weekends and 25 national holidays (including collective leave) from 366 days in a year, resulting in 293 working days equivalent to 2,051 hours or 123,060 minutes per year. If a department has two operators or employees running the machine, the total capacity time must be multiplied by the number of operators.

TC_L is calculated by multiplying 123,060 minutes by the number of employees and applies to all employees except printing operators. Printing operators have an estimated additional overtime of 5 hours per day for each operator. This means there is an additional 87,900 minutes per year (5 hours × 60 minutes × 293 days) added to the TC_L for printing operators. Then, PC_L is calculated by subtracting NPC_L from TC_L, or equivalently, by taking 80% of the TC_L value. In Table 6, the CCR_L values are presented in rupiah per minute. Employee costs are obtained from salary data, and all employees other than printing operators receive salaries without overtime estimates. The estimated overtime cost for printing operators is Rp 29,300,000, which has been included in their annual operator cost.

Tabel 6. Practical Capacity Consumed by The Product

Number of Orders	Number of Packaging	*Cutting* (min)	*Printing* (min)	*Laminating* (min)	*Creasing* (min)	*Packing* (min)
			Lbox L			
1,000	139,000	2,085	66,720		8,340	3,475
2,000	129,000	1,290	34,830	25,223	7,740	2,580
5,000	245,000	1,715	35,280		14,700	4,165
PC_A	**513,000**	**5,090**	**136,830**	**25,223**	**30,780**	**10,220**
			Sbox L			
1,000	112,000	2,240	47,040		8,400	2,800
2,000	368,000	4,600	88,320	57,300	27,600	7,360
5,000	450,000	3,600	59,400		33,750	7,650
PC_A	**930,000**	**10,440**	**194,760**	**57,300**	**69,750**	**17,810**
			Sbox XL			
1,000	37,000	925	17,760		2,775	925
2,000	56,000	840	15,120	11,460	4,200	1,120
5,000	245,000	2,205	35,280		18,375	4,165
PC_A	**338,000**	**3,970**	**68,160**	**11,460**	**25,350**	**6,210**

Source: Data processed by the researchers, 2025

The next step in the analysis is to calculate the capacity cost rate of activity (CCRA) by dividing the total activity cost (AC) by the practical capacity consumed by the activity (PCA), expressed in minutes (time), since TDABC uses time as the cost driver. In this case, the PCA is calculated based on the time equation shown in Figure 2. Before calculating the CCRA, the PCA must first be determined using the time data required for each activity, based on the type of packaging and the number of orders. The number of orders here refers to the quantity of food packaging sheets ordered per transaction, namely 1,000 sheets, 2,000 sheets, or 5,000 sheets. The PCA data are presented in Table 7.

Table 7. Capacity Cost Rate of Activity Lbox L

Activity	AC (Rp)	PC_A (min)	CCR_A
	Lbox L		
Cutting	9,476,010	5,090	Rp1,862/min
Printing	77,928,597	136,830	Rp570/min
Laminating	30,330,088	25,223	Rp1,203/min
Creasing	41,250,204	30,780	Rp1,340/min
QC and Packing	1,215,169	10,220	Rp119/min
	Sbox L		
Cutting	17,178,732	10,440	Rp1,645/min
Printing	124,382,232	194760	Rp639/min
Laminating	51,677,492	57,300	Rp902/min
Creasing	74,781,071	69,750	Rp1,072/min
QC and Packing	2,202,938	17,810	Rp124/min
	Sbox XL		
Cutting	6,243,453	3,970	Rp1,573/min
Printing	51,344,768	68,160	Rp753/min
Laminating	10,335,498	11,460	Rp902/min
Creasing	27,178,497	25,350	Rp1,072/min
QC and Packing	800,638	6,210	Rp129/min

Source: Data processed by the researchers, 2025

After the CCR_A is determined, the calculation proceeds to the product level, where the activity cost consumed by the product (AC_P) is obtained by multiplying the CCR_A by the practical capacity consumed by the product (PC_P). The PC_P is calculated based on the time equation shown in Figure 2. Table 8 presents an example of the calculation of AC_{PP}, or activity cost consumed by the product per product. The ACPP calculation is performed comprehensively, as the three types of packaging—divided into 18 packaging variants. After the AC_{PP} is determined, the direct labor cost per product (DLC_{PP}) is calculated by multiplying the PC_L, or the practical capacity of time required by employees to perform a specific activity, by the CCR_L, resulting in the DLC_P. The DLC_P is then divided by the number of orders per transaction to obtain the DLC_{PP} value. This calculation includes both the preparation process of direct labor before performing an activity and the labor involved during the activity itself. Table 9 presents an example of the DLC_{PP} calculation for the Lbox L packaging with an order quantity of 5,000 sheets and a single-sided lamination specification. The DLCP value of Rp 512.056 is divided by 5.000 sheets, resulting in a DLC_{PP} value of Rp 102 per sheet. This means that each sheet of the product with the specified characteristics incurs a direct labor cost of Rp 102 per sheet. This DLC_{PP} value will later be used together with the AC_{PP} to calculate the final cost, which represents the direct labor cost per sheet of the product.

Tabel 8. Activity Cost per Product Lbox L 5.000 sheets One-Sided Laminating

Activity	PC_P (min)	CCR_A (Rp/min)	AC_P (Rp)
Cutting	35	1.862	65.159
Printing	720	570	410.061
Laminating	225	1.203	270.563
Creasing	300	1.340	402.049
Packing	85	119	10.107
			Rp1.157.938
		Order	**5.000 sheets**
		AC_{PP}	**Rp232/sheet product**

Source: Data processed by the researchers, 2025

The final cost per product, or cost of sales product (COSP), is calculated by summing the activity cost per product, the direct labor cost per product, and the direct material cost, using the following formula:

$$COS_P = AC_{PP} + DLC_{PP} + DMC_{PP}$$

where: COS_P = Cost of Sales Product, AC_{PP} = Activity Cost per Product, DLC_{PP} = Direct Labor Cost per Product, DMC_{PP} = Direct Material Cost per Product

DMC_{PP} is calculated using the following formula.

$$DMC_{PP} = PPC_{PP} + IC_{PP} + TPC_{PP}$$

where: PPC_{PP} = Paper Cost per Product, IC_{PP} = Ink Cost per Product, TPC_{PP} = Thermal Plastic Cost per Product

The direct material cost per product includes the cost of paper (PPC_{PP}), the cost of ink (IC_{PP}), and the cost of laminating plastic (TPC_{PP}). PPC_{PP} is calculated by dividing the PP_C, which is determined based on the unit of plano sheets (large uncut paper sheets) according to the type of packaging, by the material cuts. The material cuts indicate how one plano sheet is divided based on the packaging type: one plano sheet produces 8 Lbox L sheets, 5 Sbox L sheets, and 3 Sbox XL sheets. This calculation also applies consistently across different order quantities per transaction—whether the order is for 1,000, 2,000, or 5,000 sheets.

The final step of the analysis is to calculate the cost of sales per product (COS_P). There are 54 COS_P calculations representing 18 types of packaging across three different order quantities per transaction. Table 15 presents an example of the COS_P calculation for the Lbox L packaging made of duplex 310 gsm paper with single-sided lamination for each order quantity. The DMC_{PP} (Direct Material Cost per Product) is calculated by summing the costs of paper, ink, and plastic. When calculating the paper cost, an additional 10% allowance is added to account for potential errors. For example, if the PPC_{PP} for Lbox L duplex 310

gsm is 343.8, then 34.38 (or 10% of the PPC_{PP} value) must be added before summing it with the IC_{PP} and TPC_{PP}.

Strategy Formulation based on Whale Curve

a. Profitable Customers

20.41% of customers, or 30 customers, fall into the first category, representing those who generate high contribution margins, indicated by a steep increase in the curve. This category is dominated by the company's long-term customers, who typically place orders of 5,000 sheets per transaction. These customers must be retained to prevent a decline in the company's overall contribution margin. Recommended strategies include:

1. Enhancing customer relationship management through personalized service,
2. Offering long-term contracts or Memorandums of Understanding (MoU) to bind customers to the company and prevent them from switching to competitors,
3. Implementing loyalty or incentive programs to encourage repeat purchases, such as offering cashback or exclusive merchandise for customers who order a certain quantity (e.g., 1,000,000 sheets),
4. Waiving insignificant additional fees, such as design or plate fees, when customers request design changes.

Customers in this first category contribute 58.39% of the company's total contribution margin. Therefore, this data can serve as a basis for the company to further increase customer contribution margins through retention-based strategies or policies that encourage customer loyalty and potentially boost their order volume.

b. Break-Even Customers

Overall, MOM's customer distribution is dominated by 59.86% of customers who fall into the second category, represented by a gently sloping upward curve. This group contributes 40.13% of the company's total contribution margin, which still has potential for improvement. This category presents two possible outcomes for the company: an opportunity to increase contribution margins or a risk of decrease. Customers in this category can improve their contribution margins if the company successfully understands their needs and provides consistent service quality and product quality from the first order onward. This is because customers in this category are mainly new customers and not yet as established as those in the first category. If the company fails to meet their needs, these customers may switch to competitors. Recommended strategies for customers in the second category include:

1. Encouraging larger order quantities through price negotiations,
2. Offering limited cashback incentives,
3. Streamlining service or marketing costs where possible,
4. Providing limited discounts on delivery costs.

c. Unprofitable Customers

The distribution of food packaging customers at CV. MOM, as analyzed using the Whale Curve, shows that the third category includes customers who generate low contribution margins. The details of the 29 customers in this category are presented in Table 4.32. Among these 29 customers, 20 place orders of 1,000 sheets per transaction, while the remaining 9 place orders of 2,000 sheets. The losses primarily stem from the same packaging group—Packaging Type No. 5. Based on these findings, the company should investigate the causes of the low margins, which may arise from two main factors:

1. Production costs (cost of sales) being overestimated (overvalued), or
2. Selling prices being set too low.

This issue is further addressed in the TDABC discussion. In addition, for customers who contribute low margins, it is important to identify the underlying reasons, which may be similar to those that cause losses in the third category. Therefore, cost of sales is the heart of the cause causing most customers less profitable. MOM has to immediately change their costing system from the conventional one to TDABC due to its relevancy for the complicated business characteristic in offset printing company.

The Importance of TDABC in Offset Printing Company

a. Gap between Cost of Sales before and after TDABC

The production costs calculated before and after the TDABC analysis show different results. The production cost after TDABC is Rp 266,234,623 lower than the cost calculated using the traditional method or before the TDABC analysis was conducted. This difference is caused by several production cost calculations that were previously either overestimated or underestimated by the company.

Based on the results of the Whale Curve Analysis presented in the previous section, the less profitable customers can be identified as contributing less to the company's margin, placing them in the third customer category. Customers with overvalued production costs indicate that the company's calculated production cost is too high, while those with undervalued costs mean the calculated cost is too low. Customer classified as undervalued have been charged production costs that are lower than they should be. The company can focus its strategy on adjusting the selling price, especially when there is a significant difference between the production costs before and after TDABC. A selling price that is too low may lead to losses if the actual production cost is higher.

The high production costs calculated using TDABC for packaging orders of 1,000 sheets per transaction result in a higher selling price per sheet. This indicates that the smaller the order quantity per transaction, the higher the selling price given to customers. Conversely, when the order quantity increases, the selling price per unit decreases, as the required production cost becomes lower. This occurs because smaller orders lead to higher overhead costs compared to larger orders. Therefore, the company can develop strategies to encourage customers who previously ordered 1,000 sheets per transaction to increase their order quantity to 2,000 sheets per transaction. In doing so, customers can enjoy lower selling prices, while the company gains higher margin contributions through more efficient and effective production costs.

b. TDABC as The Relevant Costing System Solution

Time-Driven Activity-Based Costing (TDABC) method serves as a highly relevant and effective costing system for CV. Megah Offset Mandiri (MOM), as it simplifies the complexity of production cost calculations across various departments. In the printing industry, where numerous machines and processes are interrelated, TDABC provides an accurate, transparent, and time-based costing structure. The method uses two main parameters: the Capacity Cost Rate (CCR) and the Practical Capacity of Activity (PCA), which together reflect the actual resource utilization during production. In the case of CV. MOM, TDABC calculations incorporated detailed production data such as activity times, machine capacities, and consumable usage. For instance, the cutting machine had a practical capacity (PC_O) of 9,287,547 sheets, with a Cost Driver Rate (CR_O) of Rp14.61 per sheet, while the printing machines (OLV52 and OLV66) operated with CR_O values of Rp100.35 and Rp118.51 per sheet, respectively. Similarly, the lamination and creasing machines had CR_O values of Rp51.94 and Rp78.24 per sheet. These rates were derived from the machine depreciation costs divided by their practical operating capacities, reflecting the actual productive time of each activity.

In addition, the practical capacity of consumables (PC_C) was determined based on 1,850,000 packaging sheets—closely matching the annual production of 2,294,000 sheets. Each 1,000 sheets required consumables such as 500 watts of electricity for cutting, 12,000 watts for printing, 1,500 watts for lamination, and 1,500 watts for creasing, along with 50 ml of machine oil. The total consumable cost per unit was then converted into Cost Driver Rates (CR_C), such as Rp157 per ml for machine oil and Rp1.45 per watt for electricity. The inclusion of direct labor costs also followed the TDABC principle by calculating the Capacity Cost Rate of Labor (CCRL). For example, printing operators had a CCRL of Rp373 per minute, reflecting both standard working hours and overtime, while other departments, such as cutting and laminating, averaged Rp341–Rp366 per minute. These figures were based on 293 working days per year, adjusted for non-productive time (20%) to reflect the practical capacity of labor. The use of time-based cost drivers makes TDABC particularly relevant for offset printing companies like MOM, where most processes rely heavily on machine operating hours and skilled operators. The application of practical rather than theoretical capacity ensures that production costs are calculated only for productive operating time, excluding idle or unproductive capacity. Therefore, By applying TDABC, CV. MOM obtained several significant advantages:

1. **Avoiding overcosting or undercosting:** The TDABC-based production cost was **Rp266,234,623 lower** than the cost calculated using the company's traditional method, revealing that previous cost estimates were mostly overstated.
2. **Transparency of unused capacity:** The 20% non-practical capacity used in the model allowed management to identify idle time and measure operational inefficiency directly.

3. **Improved operational efficiency:** The system highlighted bottlenecks and underutilized resources, helping the company optimize its machine scheduling and workforce deployment.
4. **More realistic cost rate calculations:** By combining CCR and PC_A values, TDABC provided time-based cost equations that accurately represented the real consumption of machine time and materials for each packaging type (Lbox L, Sbox L, and Sbox XL).
5. **Enhanced decision-making accuracy:** The refined cost data enabled better strategic decisions related to pricing, production planning, and customer management.

Thus, TDABC provided CV. MOM with a clear, data-driven picture of cost behavior across production activities. By capturing both the capacity supplied and the time consumed, TDABC not only improved cost accuracy but also increased managerial insight into efficiency and profitability. The method proved superior to the traditional costing system, as it produced more realistic and actionable results that directly support **profit maximization** and **competitive pricing strategies** in the offset printing industry.

c. TDABC Maximizes Profitability

TDABC produces a production cost calculation that differs from the traditional method previously used by the company. The company should have obtained a contribution margin of Rp 266,255,340 (6.31%) higher. This difference arises from the higher production costs calculated using the company's traditional method. More specifically, the TDABC-based production cost calculation indicates that the company has been underestimating (undercosting) production costs for most customers ordering 1,000 sheets per transaction across all types of packaging. Conversely, the company has been overestimating (overcosting) production costs for most customers ordering 2,000 and 5,000 sheets per transaction. Therefore, the company can reassess the selling prices of each packaging type according to the order quantity per transaction to improve competitiveness and attract more customers. Production costs that are too low (undervalued) can lead to reduced contribution margins. To address this, the company should adjust selling prices while considering market prices. On the other hand, overvalued production costs result in selling prices that are too high, which can reduce the company's competitiveness. In conclusion, the TDABC cost analysis helps the printing company optimize its profitability more accurately and effectively.

10. Conclusions

The application of Whale Curve analysis and Time-Driven Activity-Based Costing (TDABC) provides a comprehensive understanding of customer profitability and cost efficiency at CV. MOM. Based on the Whale Curve, customers are divided into three categories—profitable, break-even, and unprofitable—each requiring distinct strategic approaches. The first category, consisting of long-term customers with large order quantities, contributes the highest margins and should be retained through relationship management, loyalty programs, and long-term contracts. The second category, representing new or less consistent customers, offers growth potential that can be realized through targeted incentives and improved service consistency. The third category, composed of less profitable customers, highlights inefficiencies caused by inaccurate cost estimations and pricing strategies.

To address these issues, the implementation of TDABC proves crucial. TDABC simplifies complex cost structures and provides a more accurate reflection of resource usage through Capacity Cost Rate (CCR) and Practical Capacity of Activity (PCA). This method reveals that traditional costing has led to both overcosting and undercosting, affecting pricing and profitability. After TDABC implementation, production costs were found to be lower, indicating potential for a higher contribution margin. Moreover, TDABC enables the company to identify unused capacity, promote operational efficiency, and improve pricing precision. By understanding the cost differences across order sizes—where smaller orders incur higher overhead per unit—the company can design strategies encouraging customers to increase their order quantities, benefiting both parties. In conclusion, TDABC not only enhances cost accuracy but also strengthens strategic decision-making, pricing policies, and customer management. Combined with Whale Curve analysis, it empowers CV. MOM to maximize profitability, allocate resources efficiently, and maintain long-term competitiveness in the offset printing industry.

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