DETERMINING THE COST OF PRODUCT STORAGE SERVICES IN A REFRIGERATED WAREHOUSE USING TIME-DRIVEN ACTIVITY-BASED COSTING

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ABSTRACT

Determining the cost of goods sold in the services industry is an important decision-making process. Establishing the cost of goods sold at PT Gudang Dingin Indonesia (Gudings) as a new logistics service provider (LSP)in the cold chain sector requires a long-term plan so that the business continues to grow while parallely in broader scope aiming the sustainable development goals (SDGs) through responsible warehouse management and operation. The current tariff setting has not been formed following service specifications therefore, this research was conducted to provide a cost suggestion for storage services by implementing a time-driven activity-based costing (TDABC) method based on the activities and resources used by calculating the time taken by the company to produce services and determining the cost of goods based on cubication. The results of calculations using the TDABC method for the two types of storage services offered by Gudings, namely Storage and Fulfillment services, yield the cost of services for Storage services with the formula (55.624*x*/CBM + 10.624*xy*/CBM per day) for products stored in the freezer and (55.624*x*/CBM + 4.943*xy*/CBM per day) for products stores in cold storage. As for the Fulfillment services, the cost is based on the formula (112.815*x*/CBM + 16.994*xy*/CBM per day) for products stored in cold storage.

Keywords: LSP, cold chain, warehouse, time-driven activity-based costing, and cost of goods sold

1. INTRODUCTION

Food loss and waste (FLW) was examined from the standpoint of logistics service providers (LSPs) in a study that offered sustainable solutions with case studies of Chinese market (Yan et al., 2021). They studied the 2008–2021 literature on cold chain logistics and FLW. They identified four categories of potential reasons for FLW: (i) inadequate management; (ii) improper operating procedures; (iii) high expense; and (iv) restrictions. The findings show that the two most significant risks for FLW in LSP are facility expenses and technological inefficiency, with the absence of rules and regulations ranking second. Therefore, they advised handling these risks using sustainable solutions in social, economic, and ecological aspects. Another study revealed several ways to reduce pollution in warehouse including practicing green initiatives for its management and operations (Oloruntobi et al., 2023) as also recommended by (Tseng et al., 2019). A study (Kokubu et al., 2023) explained material flow cost accounting's (MFCA) potential contribution to the SDGs accomplishment equipped with guidance provision on how to implement it in a business. Some targeted SDGs were acknowledged such as those related to waste generation (SDG 12.2), food loss (SDG 12.4), energy (SDG 7), and many others. One recommendation would be to comprehend extended MFCA under the system boundaries of carbon foodprints of product (CFP) covering scope of material flow from the stage of raw material acquistion, production, distributio, to product disposal. In addition, managers may make more accurate decisions by using the cost information on products and material losses that MFCA can provide. Cost-management strategies like MFCA, Activity-based Costing (ABC) or other methods can enhance decision-making (Hansen et al., 1997; Susilowati, 2023) then improve supply chain management by cutting waste, streamlining processes, and increasing productivity.

A refrigerated warehouse or commonly referred to as cold storage is a facility that handles perishable food materials at a certain cold temperature to maintain freshness and quality, and extend their shelf life (Krishnakumar, 2002). Products that can be stored in a refrigerated warehouse consist of fruits, vegetables, processed meat, and other perishable food products. The storage procedure in the warehouse aims to always meet consumer demand appropriately (uncertainty demand) so that the company can respond to customer demand appropriately (Richards, 2017). Therefore, the warehouse is also useful for storing safety stock (buffer stock) to prevent inventory shortages when product demand conditions are uncertain (Haming, 2022).

According to data from the Indonesian Cold Chain Association (ARPI) which oversees the movement of the cold chain industry, starting in 2020 the implementation of the cold chain which is usually used by restaurant businesses, hotels, and tourist attractions has now shifted to small and medium-sized fresh-marts that provide frozen food products (Yasni, 2021). Based on ARPI's Indonesian cold storage growth data, the Indonesian cold chain industry will grow 25% in 2022, resulting in many competitors offering cold storage services, so companies must be able to improve their performance both in terms of service and increasing the number of customers.

According to the results of the Paxel Buy & Send Insight survey released in 2021, as many as 83% of sellers rely on social media as a place to (Paxel, 2021), MSME activists who market their products using online services and social media have grown significantly. Today, the cold chain business has also developed digitally, customer service now uses online-based services. This involves third party logistics (3PL) which acts as a storage provider on a small to medium scale. The role of 3PL in the cold chain business is a hub which is a temporary transit place to receive products that will later be sent back to another location. Hubs are needed to achieve cheaper logistics shipping costs and can reach wider points. Based on ARPI data, as of 2020 in the Jabodetabek area, 3PLs serving the cold chain business contributed 38% to the national GDP and the construction of new installations of 3.2% of the total national capacity (Yasni, 2021).

Table 1. Projection of Potential Demand for Cold Storage in Indonesia 2019-2024

Year	Cold Storage Demand Projection (Ton)	Unserved Potential (Tons & Percentage)	
2019	462,750	92,550	20%
2020	548,359	85,609	16%
2021	631,161	82,802	13%
2022	692,384	61,223	9%
2023	765,084	72,700	10%
2024	824,760	59,676	7%

As can be seen in Table 1.1, in the period from 2019 to 2024, there is a possibility of increasing demand for cold chain services by around 10% to 20% each year. In reality, in 2019 to 2020, the cold storage industry only met 34% of demand, although at the end of 2020, cold chain activity decreased by around 50,000 tons or around 58% of total demand due to the pandemic (Nurcaya, 2020), while in 2021, the cold storage industry actually needed more space than the demand projection in Table 1.1 so that according to (Puspa, 2022), it is necessary to add 105,000 tons of cold storage capacity from the previous year's available capacity of 1,875 metric tons. This is influenced by the increasing demand for frozen food, the development of retail and restaurant sector networks spread across various locations. Therefore, to maintain the demand for cold chain services, good and reliable product handling is needed in the storage process, timely delivery to customers so that product quality is maintained, especially for perishable food products (frozen food products). When refrigerated food products are damaged during the handling process, the possibility of the product not being usable becomes very high, resulting in a waste of resources. Product damage will also result in the product not being able to be traded and the product owner will experience losses because the quality of service to customers decreases. According to (Jerri, 2021) for logistics service providers (3PL), the calculation of warehouse storage costs is carried out to determine the storage service rates for customers. The determination of storage service rates from each cold storage service provider company will vary depending on the services they offer, although it may not be significant, each company will bear different operational costs. In determining the cost price in a company, all aspects of the activities that occur greatly affect the policy in determining rates to customers, because all existing activities can incur costs. Determining the cost price is important for companies, by having an appropriate cost price, the strength of demand and supply in the market can be known and the costs involved in the process can be calculated accurately. In addition, by calculating the cost price, companies can determine the margin for rates that are in accordance with their target consumers so that the potential risk of loss can be avoided. The contribution of the cost of goods sold is 92% of the set rate, where 8% is influenced by other variables, namely demand and market competition (Dewi & Wirasedana, 2015). Gudings is a service company that provides refrigerated compartment rentals (cold storage) and deliveries that serve companies and MSMEs engaged in the frozen food industry (https://gudings.id/, 2020). Gudings stores various types of frozen food from various partners such as chicken carcasses, boneless chicken, otak-otak, dumplings, and others. The company has a policy that every order received must be received and handled properly to avoid product damage during storage until the product is finally sent out of the warehouse.

The fierce competition in the logistics business world today requires service providers to hone their accounting management system capabilities (Karmazin, 2014). In its storage services, currently Gudings at the Menteng Asri warehouse in Bogor, has 2 types of storage services, namely storage-only services and fulfillment services. Storage-only services are Gudings storage services where customers can store their products in Gudings storage facilities while fulfillment services are also storage services provided by Gudings where customers can store their goods and get additional services, namely packing (product packaging), stock-counting (counting the number of products that come out and remain in Gudings) and stock opname (adjusting the number of physical stock with the data). The following is a graph of the proportion of Gudings' gross income for 6 months for shipping and storage services in May 2022 - October 2022. It can be seen in the graph that in each month the largest proportion of gross income is obtained from storage services. Based on the results of this graph, the research was narrowed down to storage services because they

are considered to have a greater influence on this company. In addition, based on observations made, it was found that Gudings' core business is storage services.

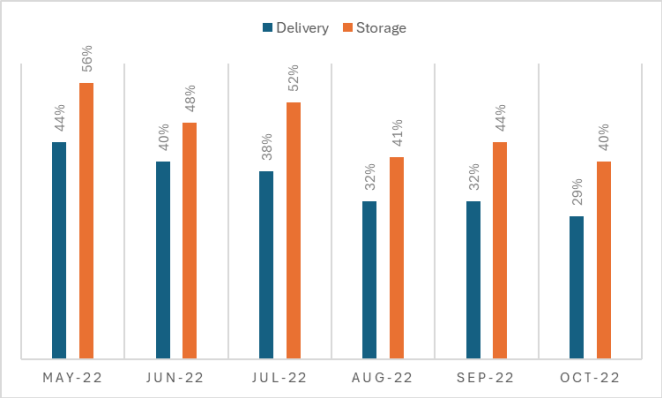

Figure 1. Gudings Income for May 2022

The company currently sets the cost of storage services by considering several things such as the amount of electricity used, worker wages, and equivalent competitor rates such as Fresh Factory. The current tariff determination is still set simply and conventionally through estimates only, not through quantitative calculations and determining cost factors randomly. In determining service costs, there are several cost components that should have an influence but are not considered, such as the time factor of the activities carried out based on the type of service chosen by the customer and the overhead cost in each service chosen by the customer (Cooper & Kaplan, 1988). Overhead costs are costs that are indirectly related to the process of making products or services (Tuovila, 2024) which in this study, overhead costs are found in every storage and packing activity carried out by Gudings. This cost is one of the things that needs to be considered to determine the cost burden that must be borne by the company to be able to accurately determine rates to customers according to the services chosen to generate business profits and ensure the sustainability of the company. Overhead costs are costs that are indirectly related to the formation of services (Tuovila, 2024). Examples of overhead costs in storage activities are depreciation costs for refrigerated storage facilities and employee health insurance costs (CFI Team, n.d.). The difficulty in calculating overhead costs is because these costs are difficult to observe (unobservable) (Hakim, 2018) and it requires details regarding costs that are indirectly involved in service services so that good accounting bookkeeping is needed and minimizing expenses that are difficult to identify. Gudings as a new company in the cold chain sector needs a long-term plan so that its business continues to grow, but the simple tariff determination (traditional costing methods) carried out by Gudings currently does not always provide the information needed to make long-term decisions such as examples of complete historical sales data. The tariff determination currently given to customers does not yet reflect the actual costs incurred. This is related to the determination of the basic cost of service owned by Gudings has not been prepared according to the details of the services provided. It is important to know information about the amount of actual service costs and activity efficiency costs to reduce the total cost of the service process to generate optimal profit for the company. Considering the influence of cost calculations on service provision, profitability measurements are needed to determine the costs and rates of these services (Bokor & Markovits-Somogyi, 2015).

Gudings as one of the newly developing companies as a provider of refrigerated storage has a challenge to be able to compete in the cold chain industry. Gudings needs to think of ways to improve the quality of service but still be able to minimize costs incurred so that the company can still be trusted by customers. The determination of the cost price currently applied by Gudings is not in accordance with the existing theory, namely by benchmarking with its competitors, theoretically the determination of the cost price, especially in the service sector, involves overhead costs and the determination of the current cost price has never been reviewed by expertise. The lack of costs that should be considered can cause cost distortion so that the cost price owned is less than appropriate. Therefore, a proposal is needed to determine the cost price of services using the time-driven activity-based costing method that considers activities during the storage service business process and costs incurred during activities including overhead costs. To solve problems regarding costs and time spent by the company, it can be solved using the activity-based costing method. Activity-based costing is an accounting approach method by charging resource costs to objects. ABC can provide a clear understanding of how a company differentiates products, services, and activities that contribute to the long term. However, costing using the activity-based costing method has several weaknesses, including if resources work at full capacity without considering labor allowances during activities (Oktavia, 2015). So that the method is refined into time-driven activity-based costing.

The determination of the cost of goods sold with traditional costing is made simple, with costs determined based on the use of its resources (Satria, 2016) and is generally used for businesses with low product variations. With activity-based costing (ABC) and time-driven activity-based costing (TDABC), the price is determined on the activities carried

out to produce services and the costs used, described in detail. However, the disadvantages of activity-based costing which are also found in traditional costing are that the determination of service costs is not flexible and there is also debated to respond to subjectivity in determining cost drivers (Hakim, 2018). Determination with traditional methods cannot reflect changes in situations, for example related to the elasticity of demand in business (Riediansyaf, 2014). Its rigid application to change makes this method take a long time to implement if there is a change in the business. So, it was refined into time-driven activity-based costing which added a time equation to answer the complexity of business activities (Kaplan & Anderson, 2007). In addition, in the ABC and TDABC methods there is a cost driver rate where the cost driver rate identifies the amount of resources consumed by business activities as a cost driver (Banton, 2023). The activity-based costing method considers the number of activities (activity cost driver) but does not consider the amount of activity time (time cost driver) as in the TDABC method. According to (Dejnega, 2011) the ABC method does not capture detailed activity specifications so that it affects the total cost while the TDABC method includes assigning costs to activities in detail but in some cases, time estimates are based on subjective assessments. In this study, a proposal will be made to determine the cost of Gudings' storage services more systematically by considering the activities carried out and the overhead costs of each storage service variation, namely storage services only and fulfillment storage services using the time-driven activity-based costing (TDABC) method. The results of the proposed determination of the cost of services are expected to be a reference for Gudings in determining the rates for each of its storage services so that Gudings can determine the appropriate amount of profit and can also estimate the allocation for other costs such as research & development costs and owner salaries and evaluation of the current tariff prices compared to its competitors. This study will use the Time-driven activity-based costing method which is a development of the activity-based costing method approach developed by Kaplan & Anderson in calculating the cost of services or products that have higher accuracy in determining service costs (Cooper & Kaplan, 1988). The TDABC method is based on the time used by the company to carry out activities in producing services. The ABC method has two two-stage cost calculation systems, namely determining costs for activities and then the next stage charging them to services/products or customers (Tsai, 1998). While the TDABC method, cost determination is carried out by managers who will estimate the resources needed by each transaction. The concept of activity-based costing was developed to overcome problems regarding cost distortions that often arise with the traditional costing system (Cooper & Kaplan, 1988). The TDABC method is commonly used to calculate costs by allocating overhead costs which are considered as one of the cost components so that companies can determine appropriate prices for their cold storage service rates. So it can be formulated that the problem in this study is how to determine the basic price of storage services for perishable food products in a refrigerated warehouse, Gudings by considering the activities that make up its operational activities (activity pool), the time required (time equations) and other factors (labor, infrastructure) that affect the cost of storage services, using the Time-driven Activity-based Costing method.

2. LITERATURE REVIEW

Cold Storage

Cold storage according to Supply Chain Indonesia (Lestari, 2020) is a room that is specially designed using technology or a system used to store goods or products, especially those that have characteristics that are easily damaged with a cooling system. Generally, cold storage is used in the ice cream, fish, meat, fruit, vegetable and pharmaceutical industries. Cold storage is a storage room that is specially designed with a certain temperature with the main aim of maintaining the quality and freshness of the stored products and extending the storage life (Khan et al., 2022). According to (Bremer, 2018) products stored in cold storage are stored at a temperature range between -18 ° C (deep frozen) and up to 14 ° C. Today, customers demand the market by providing high quality, fresh, and healthy food ingredients, from which, cold chain is no longer an option but a necessity (Cerchione et al., 2018).

Cost of Services

Every company in producing products or services will carry out a process that incurs expenses in the form of expenses or costs. The accumulated results of these costs are called the cost price which is then used as a reference in determining the selling price set for customers. This is also the same as service companies, although the products produced are not in goods such as manufacturing companies or in the form of inventory sold in trading companies (Suharti, 2016). Service companies sell services in their business activities in exchange for products sold in manufacturing companies or trading companies. According to (Utami, 2023), the term HPP or COGS (Cost of Goods Sold) is not known in the financial statements of service companies. In service companies, the cost price is called the cost of revenue (COR) because service companies do not sell products in the form of tangible goods so there is no stock or inventory of goods. Cost of revenue according to (Utami, 2023) is the total cost arising from the service process for services provided to customers. Costs such as raw material costs, direct labor costs, shipping costs and sales or marketing commissions are components of the cost of services.

Components of Warehousing Service Cost of Goods Sold

According to (CFI Team, n.d.), the cost of goods sold is defined as the costs required to produce services or products. These costs include material costs, direct labor costs, storage costs, and direct overhead costs such as depreciation costs. The basic purpose of determining the cost of goods sold is to calculate the 'true cost' of a product or service in a period (CFI Team, n.d.).

According to (Lupiyoadi, 2014), something or an activity that is given by one party to another party is intangible and does not involve any transfer or ownership. For logistics service providers (3PL) that manage warehouses, it is necessary to determine the appropriate service tariff rate which has a calculation like the price rate of a product, but the difference is that there is no raw material price in services. Types of services and price components related to determining the cost of goods sold, namely:

a. Warehouse Storage Services. Storage services are the amount of costs charged to the warehouse. The amount of the costs charged is charged for warehousing service costs, in this case the use of resources. In general, activities in a warehouse start from the process of receiving goods (receiving), placing goods (put away) and sending goods (shipping) (Jerri, 2021). To carry out these warehousing activities, resources are needed such as warehouses, material handling equipment or supporting equipment for handling materials, equipment, human resources, and technology. The types of warehouse costs are distinguished based on the type of resources used in the warehouse according to (Richards, 2017), namely:

    1. Storage costs are costs incurred due to the use of space in the warehouse. The components of this storage cost consist of building rental costs or building depreciation, building taxes, maintenance costs, refrigeration equipment costs if the warehouse is refrigerated and others.
    2. Handling costs, costs originating from the process of handling products in the warehouse such as direct human resource costs (manpower), MHE costs and packaging costs are handling, costs originating from the process of handling products in the warehouse such as direct labor costs, MHE costs and packaging costs.
    3. Overhead costs, costs paid for supporting business process activities such as marketing costs, development costs.

    Meanwhile, according to (Utami, 2023), the components included in the cost of services or cost revenue in service companies are:

    1. Raw Material Costs. Service companies generally do not use this component as the main component in producing their services. Usually owned by companies that produce products.
    2. Direct Labor Costs (BTKL). This cost is the salary given to workers who are directly involved in the service process created.
    3. Shipping Costs. Costs incurred during shipping activities or transportation costs, one of which is the gasoline cost component.
    4. Marketing Costs. Cost components related to business marketing, such as advertising costs.

b. Packing Services. Packing activities are carried out as value-added activities that add value to services to customers. Especially for food products, good packaging techniques are needed so that the product is protected from external causes of damage such as oxygen, humidity, shocks during shipping and maintains product quality (Sucipta et al., 2017). In the packaging process, the costs involved include raw materials and human resources.

3. METHOD

Working Time Measurement and Determination of Standard Time

Frederick W. Taylor was the first developer in measuring working time with the stopwatch method. This method is a method that is suitable for work that takes place repeatedly (repetitive). According to (Wignjosoebroto, 2000), the output of the measurement activity is standard time. Standard Time is the standard time for all workers to complete a work cycle. Characteristics in measuring working time with a stopwatch include (Astuti & Iftadi, 2016): the work activities carried out are homogeneous, the activity is carried out repeatedly (repetitive), the output is real so that it can be expressed quantitatively.

The steps when conducting a measurement with a stopwatch are as follows.

1. Measuring and recording the observation time of each activity element with a certain number of repetitions.

2. Conducting a data uniformity test which aims to determine the homogeneity of the data, data sources from the same population and extreme data are equalized in the calculation.
3. Data adequacy test is carried out. Data adequacy testing will greatly affect the level of accuracy and confidence. If the level of accuracy is 5% and the level of confidence is 95%, it means that the measurer provides an average limit for the measurement results that deviate by 5% from the actual average and the probability of success is 95%.

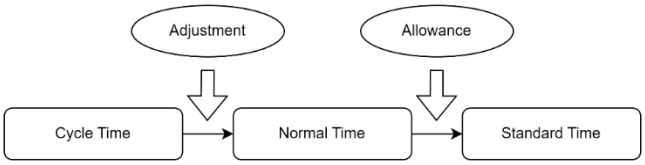

Figure 2. Standard Time Calculation Stages

According to (Wignjosoebroto, 2000), standard time is the time required for a worker where the worker being studied has the ability within the average limit to complete a job. Determining standard time is very useful in scheduling work where the duration of an activity is also stated how many workers are needed when completing the job. Standard time can be determined through two stages, namely: adding adjustments to cycle time to produce normal time and adding allowance to normal time to produce standard time (Figure 2).

4. RESULTS AND DISCUSSION

Storage services are Gudings' services that have the largest income. Considering the research time, the object of observation is limited to storage services. Currently, Gudings offers two types of storage services, namely storage-only services and fulfillment storage services. In storage-only services, Gudings provides product storage services at Gudings storage facilities. While for fulfillment storage, Gudings provides storage services with additional activities as value-added services such as product packaging (packing), recording products leaving the storage area (stock-counting) and customer stock availability reports (stock opname). Since Gudings provides storage services to business actors, there are various types of perishable products handled by Gudings. The following are the products currently handled by Gudings: Chicken Carcass, Potato Wedges, Potato French Fries, Fried Cassava, Meatballs, Fish Roll, Dumplings Wonton, Okado, Ebi Furai, Chicken Spring Roll, Samosa, Shumai, Chicken Gyoza, and many more that stored at varied temperature between -25^o to -18^oC. The products handled by Gudings are perishable goods that have a short life cycle, are vulnerable to time and place, which means they require special handling to maintain the quality and freshness of each product stored using two main storage facilities of cold storage and freezer.

To support its business process in storage services, Gudings has 2 human resources consisting of Admin Staff and Warehouse Staff with a monthly cost incurred by Gudings of Rp 4,800,000. Gudings is a start-up service provider for small-scale industrial logistics services that is still developing, all operational activities are carried out simply, do not yet have clear business management, and its financial balance bookkeeping is not properly archived. This results in Gudings' inaccuracy in determining the amount of expenditure, confusion in seeing the profit and loss of services and determining the number of services that must be performed to generate profits. The determination of the rates currently given to customers does not reflect the total costs actually incurred. This is related to the determination of the cost of services owned by Gudings which has not been prepared in accordance with the details of the services provided. Based on these problems, the use of the time-driven activity based-costing method can provide a more detailed calculation of the cost of goods sold, so that it can help Gudings determine the amount of profit desired based on its cost.

Data Collection

The data requirements for determining the cost of storage services at Gudings consist of the storage service business process obtained through interviews with the owner of Gudings and conducting direct field observations, calculating standard time, workers and operational costs. Gudings operates from Monday to Saturday. Working hours at this company start at 08.00 to 18.00 GMT+7 with 1 hour break on Monday to Friday, while on Saturday working hours start at 08.00 to 12.00 without any break.

Business Process

The service process Gudings is carried out from Monday to Saturday and storage for 24 hours. In making an order for product storage, customers contact the Gudings admin via telephone call or send a message via WhatsApp media. Customers convey the type of product to be stored, product packaging, quantity and length of storage. The availability of warehouse space will be ensured by the admin staff and then its availability will be confirmed to the customer via the admin. The next process regarding the rates set for customers will be carried out by the Gudings owner in the rate

negotiation activity followed by a rate agreement and cooperation agreement and payment. Orders that have been formed will be prepared in place while waiting for the product to arrive at Gudings. Products that have arrived will be unloaded in the inbound area by the sender while checking the conformity with the delivery note and PO. When the product sent is found to be not in accordance, the product is recorded as not in accordance and sent back to the customer. Furthermore, the product that has been in accordance is calculated in quantity and the condition of the product is checked. If the product is found to be damaged or defective, the product will be returned to the customer. Furthermore, the admin will issue a product receipt letter, responsibility for the product will be transferred to Gudings. The products are then classified into storage areas based on packaging form and weight. Products that come to Gudings can be in tally units, cartons or bags, making it easier to determine the appropriate storage area (cold storage or freezer). During the storage process, periodic monitoring of the storage area temperature is carried out to keep the area temperature cool and product checks are carried out during storage to ensure that the product does not fall and is safe.

The process of leaving the product from the warehouse begins when the customer sends a request to remove their product from the storage area, the request is received by the admin and then processed immediately. If the service is a storage-only service, the admin will process the request into a picking list order which will later be submitted to the warehouse staff. The warehouse staff will carry out the product picking process according to the picking list and give an okay mark on the product that has been taken. The products that have been taken will be checked for both SKU and quantity, if there is a discrepancy, the warehouse staff will return to pick up the appropriate product. When the product is in accordance with the picking list, the product is ready to be picked up by the customer. The customer can pick up the product by a party that has been verified or previously informed. When the product's outbound request is a fulfillment service, the warehouse staff will carry out the same picking process as the storage service and then continue with the product packing process. After the product has left the warehouse, the admin will record the type of product, day, date and number of products that have come out (stock-counting). In the fulfillment service, the products that are stored will be stock taken as a report on the availability of customer stock. After knowing the flow of product storage services from the ordering process to the product leaving the warehouse, the next step is to create a resource matrix. In the resource matrix, you can see the series of activities carried out by each party and their responsibilities.

Cost Identification

The fixed assets owned by Gudings support the operational business process of storage services in its company. Each asset owned has an economic life which means that during a certain period it is expected to contribute to the company. The economic life of each asset owned is based on the Decree of the Minister of Finance of the Republic of Indonesia No. 295 / KM.6 / 2019. It is hoped that these assets will be able to support the services provided to generate maximum income.

The total cost is the total cost used for the storage activity process at Gudings outside of fixed assets. There are two cost components involved, namely direct cost components and indirect costs. For direct costs, the cost components consist of labor costs (admin, warehouse staff, allowance, operational manager) and consumable costs, then for indirect costs consist of investment costs (freezer, cold storage, laptop, printer, hand pallet trolley, scales) which experience depreciation from facilities and other costs (internet, office electricity, freezer electricity, cold storage electricity, office supplies, cleaning, wareohuse maintenance, Zahir software, website). The proportion of costs is divided into activities carried out by each service. This is because resources and facilities are used simultaneously. The division is done by dividing the number of activities in one service by the total number of activities. The storage service only has a 38% proportion of the total cost, and the fulfillment storage service has a proportion of 62% of the total cost. We estimate the costs incurred by Gudings in one year to carry out the storage service only and the fulfillment storage service respectively in which for the second, we also consider packing raw material cost under direct material of direct cost type.

Activity Pool

Activity pool is a step in mapping activities based on a company's business activities. The output of the activity pool is as input (input result) for the classification of standard time calculations. The creation of the activity pool is based on the business process unit currently run by Gudings, namely storage services. Activity grouping is determined based on the main activities in the warehouse according to (Richards, 2017) which consist of receiving, putting away, storage, picking, packing, stock-counting, and stock opname. Activities in Gudings start from order creating activities, namely recording incoming orders, checking the availability of storage areas, negotiating rates, to recording incoming payments. In the receiving activity group, the activity begins when there has been cooperation between Gudings and the customer. The activity begins with printing out the purchase order letter from the customer, preparing the storage area, checking the product until signing the delivery note. In the put away activity group is the activity of placing products into the storage area. There are two activities, namely checking the products to be put away and the put away activity itself. Furthermore, the products that have been put away at the storage location will be checked and their temperatures monitored to maintain the quality of the stored products. Both activities are storage category groups.

Next is the picking activity which is the activity of taking products according to the storage area. If the request from the customer to remove the product has been received by Gudings, then recording and confirmation of the product to be removed, picking the product from the storage area, until confirmation of picking complete as a group of picking activities.

For customer products with fulfillment services, there are additional services, namely packing, stock-counting, and stock opname activities. So that the series of fulfillment storage service activities consist of order creating, receiving, putting away, storage, picking, packing, stock-counting and stock opname activities. In the packing activity, there is the activity of packaging the product to be taken, attaching the product description, and confirming readiness when the product is ready to be picked up which is categorized as the packing activity category. Next, there is the activity of recording outgoing product stock and updating product stock as a group of stock-counting activities. Then, the activity of calculating the number of physical stock products in Gudings and adjusting it with digital data becomes a stock opname activity group. The results of the stock-opname activity will be given as a report on the availability of goods to the owner of the goods (customer).

Standard Time

After observing this activity, a data uniformity test was conducted statistically using Microsoft Excel. The data uniformity test is conducted and produces data output based on observations that are said to be uniform if the observed data values obtained are not outside the upper and lower limit control. The next step is the data adequacy testing statistically then determine whether the observation data that has been taken is sufficient to represent the population. In this study, a 90% confidence level (k = 2) and a 10% accuracy level (s = 0.1) were used. The calculation of the standard time and normal time of a job needs to consider the allowance and performance rating. Based on the time data that has been taken using the time study method for 0.1 CBM of the product, we can calculate the standard time using a 10% allowance for each activity pool.

Economic Resources Identification

Identification of resources in this study is needed to determine the resources available at Gudings in carrying out all activities in the storage service every day. Resources at Gudings consist of labor, infrastructure, office equipment and supplies, technology, and others to support activities. To calculate the cost (unit cost) is done by first calculating the total capacity cost or the cost incurred to finance the capacity at PT Gudang Dingin Indonesia for one year. In this study, resources are identified into 2 groups, namely labor resources that are directly related to labor and storage facility resources. The two resource groups will be divided into direct costs and indirect costs. Direct costs consist of direct labor wages, and consumable costs. Indirect costs that are calculated are overhead costs in the form of internet usage costs, electricity, office supplies, warehouse maintenance, Zahir software (accounting recording application) and cleaning costs. The cost components of the labor resources group consist of labor, technology and information, and tools while the cost components of the storage facility resource group consist of electricity costs for freezers and cold storage and their depreciation costs.

Practical Capacity

Practical capacity is the actual amount of time available for workers to run business processes by considering productive and non-productive conditions. The process of calculating practical capacity produces the total time available (available time) in the company to run its business processes which is then used for the capacity cost rate input. The calculation of practical capacity for Gudings is done by calculating the working hours applied by Gudings multiplied by the number of workers. Gudings applies nine hours of working time and for storage facilities it is calculated as 24 hours because it is a refrigerated storage facility. The calculation of practical capacity is done for both resource groups that have been determined by calculating the difference between working hours and holiday hours and then multiply it by the number of workers. For practical capacity of technology & information and equipment & tools, it is assumed that their use is linear with the effective working time of the workforce. Next is calculating the practical capacity of the storage facility. Because Gudings is a cold chain business, its storage facilities will always operate 24 hours a day throughout the year without being affected by holidays. So, the practical capacity for the storage facility was calculated for 24 hours.

Capacity Cost Rate

Capacity cost rate is the ratio of the total cost calculation of each resource to its practical capacity. The purpose of calculating the capacity cost rate is to find out the total cost incurred by the company in a unit of time. The capacity cost rate calculated by dividing the total cost by the practical capacity. Next, the capacity cost rate calculation is carried out for each service that is the subject of the research. The total cost incurred by Gudings for the labor resource group is IDR 86,046,154 with a total practical capacity of 17,094 hours/year therefore the capacity cost rate is IDR 5,034 per hour. Meanwhile, the total cost incurred by Gudings for the storage facility resource group is divided into two

based on the type of facility, namely freezer and cold storage, so there are two capacity cost rates for storage facilities. From the calculation, the freezer capacity cost is IDR184 per hour, IDR 4,425 per day and the cold storage capacity cost rate is IDR 2,832 per hour, IDR 67,966 per day.

In the fulfillment service, the total cost incurred to run this business service for the labor resource group is IDR 138,933,846 with a total practical capacity of 17,094 hours/year, so the capacity cost rate for the labor resource group is IDR 8,128 per hour. Furthermore, the capacity cost rate for the freezer storage facility resource is IDR 295 per hour, IDR 7,081 per day and the capacity cost rate for cold storage in this service is IDR 4,531 per hour, IDR 108,746 per day.

Time Equation Model

The determination of the time equation model aims to determine the total time needed by Gudings to carry out storage service activities to its customers as can be seen in Table 2. The time equation model uses predetermined standard time as input for determining the model.

Table 2. Summary of Time Equation Model for Each Activity

Activity (hour)	Equation Model
Order Creating	$0.066X_1 + 0.064X_2$
Receiving	$0.069X_1 + 0.46X_2$
Put Away	$0.007X_2$
Storage	$0.32X_1 + 0.029X_2$
Picking	$0.025X_1 + 0.104X_2$
Packing	$0.17X_1 + 0.038X_2$
Stock-counting	$0.003X_2 + 0.03X_3$
Stock-opname	$0.059X_1 + 0.066X_2$

In which:

$X_1 = number\ of\ order$

$X_2 = number\ of\ product$

$X_3 = number\ of\ product\ type$

Calculation of Cost of Goods Sold Using Time-Driven Activity-Based Costing Method

The cost of service for fulfillment storage services depends on the number of products handled with additional activities such as packing, stock-counting and stock-opname. These activities will affect the total time of the overall activity. The details of cost calculation for every service as shown in Table 3.

Table 3. Gudings Storage Service Cost Formula

	Facility Type	Equation Model
Storage Service	Freezer	$46.353x + 8.851xy$
	Cold Storage	$46.353x + 4.119xy$
Fulfillment Service	Freezer	$102.346x + 14.162xy$
	Cold Storage	$102.346x + 6.591xy$

In which:

$x = total\ of\ product\ volume\ (CBM)$

$y = storage\ duration$ (day)

The determination of storage rates is based on the type of storage service, product volume (CBM), number of products, and storage time (days). So that the storage rate formula obtained using the time-driven activity-based costing method in Gudings is as follows in Table 4, assuming a margin of 20%.

Table 4. Gudings Storage Service Rate Formula

	Facility Type	Equation Model
Storage Service	Freezer	$55.624x + 10.621x$
	Cold Storage	$55.624x + 4.943xy$
Fulfillment Service	Freezer	$122.815x + 16.994xy$

	Cold Storage	$122.815x + 7.908xy$

Discussions

The proposed service cost using this method maps each work element that occurs during storage activities into an activity pool. The standard time is taken using the direct-stopwatch time study method which is carried out for 0.1 CBM based on the results of the Standard Time calculation and data uniformity checks. It is known that there is a tendency for fluctuation because the activity is carried out by human resources where many factors may occur so that consideration components need to be included in the standard time calculation. The estimated total cost required for storage services is only IDR 112,469,231 and fulfillment services are IDR 181,210,769 in one year. This total cost estimate has considered the amount of facility depreciation and manager salaries which in existing conditions have not been determined so that the total cost incurred by the company in units of time for each type of storage service is obtained.

The proposed service cost price obtained is then implemented against the rate with a margin of 20% to see the position of the proposed service cost price against the current Gudings rate. Currently, Gudings sets the storage rate given to customers based on the actual weight of the product itself. However, in the storage business, the determination of warehouse costs is determined based on the cubic volume of the product to be stored. For example, there is a product that will be stored weighing 500 kg for 30 days with certain product characteristics that will be stored in a freezer using a fulfillment service with 2 stock takes and 7 stock counts. The following Figure 3 shows a comparison of Gudings storage rates based on the actual weight of the product and the cubic volume of the product using the TDABC method and the current Gudings rates.

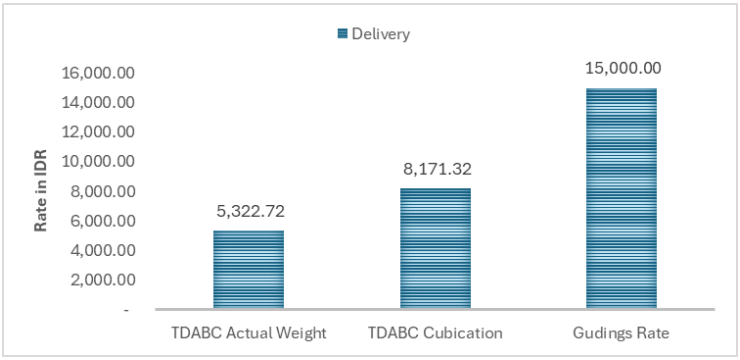

Figure 3. Storage Rate Comparison

The current Gudings rate is the highest rate when compared to the rate using the TDABC method, both calculated by actual weight and cubic. The current Gudings rate with the TDABC actual weight rate has the same calculation of storage rates based on the actual weight of the stored product. The final rate difference between the Gudings rate and the TDABC method is the number of activities used. The Gudings rate does not consider the number of activities carried out because of the number of products handled, although the basic rate per kilogram of Gudings is lower. While the rate based on cubic is calculated based on the dimensions of the product handled, not based on the actual weight of the product. Calculations based on cubic are considered more appropriate because in the case of warehouse storage, there is a correlation between the size of the warehouse and the dimensions of the product stored in the same area unit.

5. CONCLUSION

Storage services at Gudings are divided into 2 service variations, namely storage services only and fulfillment storage services. The cost of services is based on cubic or equal to cubic meters. With cost components consisting of labor costs and raw material costs for the packing process, where the components are direct costs, then indirect cost components at Gudings such as freezer/cold storage depreciation costs and electricity costs. So that the Gudings service cost formula is determined which consists of the sum of service costs and storage costs. The use of the time-driven activity-based costing method in calculating the cost of Gudings storage services can describe the activities during the storage business service process and detailed cost components. The cost of services offered using the TDABC method is expected to be a proposal and consideration for companies to determine their cost to minimize the potential for cost distortion and determine profit projections. Due to time constraints in the research process, further research is expected regarding the determination of tariffs for storage services using other methods as a comparison to obtain a better understanding of the business.

6. REFERENCES

Astuti, R. D., & Iftadi, I. (2016). *Analisis dan Perancangan Sistem Kerja*. Deepublish.

Banton, C. (2023). *Activity Cost Driver: Definition and Examples*. Https://Www.Investopedia.Com/Terms/a/Activity-Cost-Driver.Asp#citation-1.

Bokor, Z., & Markovits-Somogyi, R. (2015). Applying Activity-based Costing at Logistics Service Providers. *Periodica Polytechnica Transportation Engineering*, *43*(2), 98–105.

Bremer, P. (2018). Towards A Reference Model for The Cold Chain. *The International Journal of Logistics Management*, *29*(3), 822–838.

Cerchione, R., Singh, R., Centobelli, P., & Shabani, A. (2018). Food Cold Chain Management: From A Structured Literature Review to A Conceptual Framework and Research Agenda. *The International Journal of Logistics Management*, *29*(3), 792–821.

CFI Team. (n.d.). *Cost of Goods Sold (COGS)*. Https://Corporatefinanceinstitute.Com/Resources/Accounting/Cost-of-Goods-Sold-Cogs/.

Cooper, R., & Kaplan, R. S. (1988). Measure Costs Right: Make The Right Decisions. *Harvard Business Review*, *66*(5), 96–103.

Dejnega, O. (2011). Method Time Driven Activity Based Costing–Literature Review. *Journal of Applied Economic Sciences (JAES)*, *6*(15), 9–15.

Dewi, F. C., & Wirasedana, I. (2015). Analisis Beda Dua Rata-Rata Metode Time-Driven Activity-Based Costing pada Industri Garmen. *E-Jurnal Akuntansi Universitas Udayana*, 796–810.

Hakim, T. I. M. R. (2018). Activity-Based Costing and Its Derivatives and Significance in the Cutting-Edge Environment. *TIJAB (The International Journal of Applied Business)*, *2*(2), 107–122.

Haming, M. (2022). *Manajemen Produksi Modern: Operasi Manufaktur dan Jasa*. Bumi Aksara.

Hansen, D. R., Mowen, M. M., & Heitger, D. L. (1997). *Cost Management*. South-Western College Publishing.

https://gudings.id/. (2020). *About Us*.

Jerri. (2021). *Biaya Gudang*. Https://Fit.Uii.Ac.Id/Blog/2021/08/01/Biaya-Gudang/.

Kaplan, R. S., & Anderson, S. R. (2007). *Time-driven Activity-based Costing: A Simpler and More Powerful Path to Higher Profits*. Harvard business press.

Karmazin, G. (2014). Research Results on The Key Success Factors of Hungarian Logistics Service Providers. *Periodica Polytechnica Transportation Engineering*, *42*(2), 91–95.

Khan, M. I., Khan, S., & Haleem, A. (2022). Analysing Barriers Towards Management of Halal Supply Chain: A BWM Approach. *Journal of Islamic Marketing*, *13*(1), 66–80.

Kokubu, K., Kitada, H., Nishitani, K., & Shinohara, A. (2023). How Material Flow Cost Accounting Contributes to The SDGs Through Improving Management Decision-Making. *Journal of Material Cycles and Waste Management*, *25*(5), 2783–2793.

Krishnakumar, T. (2002). Design of Cold Storage for Fruits and Vegetables. *Tamil Nadu Agricultural University*, 1–58.

Lestari, S. F. W. (2020). *Gudang Berpendingin (Cold Storage)*. Https://Supplychainindonesia.Com/Gudang-Berpendingin-Cold-Storage/#:~:Text=Cold%20storage%20adalah%20ruangan%2Fgudang,Dengan%20tujuan%20untuk%20mempertahankan%20kesegarannya.

Lupiyoadi, R. (2014). *Manajemen Pemasaran Jasa Berbasis Kompetensi*.

Nurcaya, I. A. H. (2020). *Tren Frozen Food, Pasar Daerah Pacu Kapasitas Rantai Pendingin*. Https://Ekonomi.Bisnis.Com/Read/20201218/257/1332890/Tren-Frozen-Food-Pasar-Daerah-Pacu-Kapasitas-Rantai-Pendingin.

Oktavia, D. (2015). Implementasi Time Driven Activity Based Costing (TDABC) pada Usaha Kecil Menengah (UKM) Tape Handayani 82 Bondowoso. *Jurnal Akuntansi Universitas Jember*, *11*(2), 1–19.

Oloruntobi, O., Mokhtar, K., Rozar, N. M., Gohari, A., Asif, S., & Chuah, L. F. (2023). Effective Technologies and Practices for Reducing Pollution in Warehouses-A Review. *Cleaner Engineering and Technology*, *13*, 100622.

Paxel. (2021). *Paxel Buy & Send Insights: UKM Lebih Suka Berjualan di Media Sosial*. Https://Paxel.Co/Id/Berita-Dan-Promo/Paxel-Buy-and-Send-Insights-Ukm-Lebih-Suka-Berjualan-Di-Media-Sosial.

Puspa, A. W. (2022). *Kinerja Logistik Cold Chain Terdongkrak Frozen Food*. Https://Ekonomi.Bisnis.Com/Read/20220710/98/1553279/Kinerja-Logistik-Cold-Chain-Terdongkrak-Frozen-Food.

Richards, G. (2017). *Warehouse Management: A Complete Guide to Improving Efficiency and Minimizing Costs in The Modern Warehouse*. Kogan Page Publishers.

Riediansyaf, M. D. (2014). The Application of Time Driven Activity Based Costing in The Hospitality Industry: An Exploratory Case Study. *The Journal of Applied Management Accounting Research (JAMAR)*, *12*(1), 27–54.

Satria, M. R. (2016). Perbandingan Sistem Biaya Tradisional dengan Sistem Activity Based Costing dalam Perhitungan Harga Pokok Produksi: Perbandingan Sistem Biaya Tradisional dengan Sistem Activity Based Costing dalam Perhitungan Harga Pokok Produksi. *Competitive*, *11*(1), 16–28.

Sucipta, I. N., Suriasih, K., & Kencana, P. K. D. (2017). Pengemasan Pangan Kajian Pengemasan yang Aman, Nyaman, Efektif dan Efisien. *Udayana University Press*, *1*, 1–178.

Suharti, S. (2016). Perhitungan Harga Pokok Produksi Perusahaan Jasa Kurir Studi Kasus PT Pos Indonesia (Persero). *EKUBIS*, *1*(1), 72–81.

Susilowati, E. (2023). Cost Management and Strategic Decision Making: The Role of Managerial Accounting. *Atestasi: Jurnal Ilmiah Akuntansi*, *6*(1), 457–473.

Tsai, W. (1998). Quality Cost Measurement Under Activity-based Costing. *International Journal of Quality & Reliability Management*, *15*(7), 719–752.

Tseng, M.-L., Islam, M. S., Karia, N., Fauzi, F. A., & Afrin, S. (2019). A Literature Review on Green Supply Chain Management: Trends and Future Challenges. *Resources, Conservation and Recycling*, *141*, 145–162.

Tuovila, A. (2024). *Overhead: What It Means in Business, Major Types, and Examples*. Https://Www.Investopedia.Com/Terms/o/Overhead.Asp.

Utami, N. W. (2023). *Cara Menghitung HPP Perusahaan Jasa (Cost of Revenue)*. Https://Www.Jurnal.Id/Id/Blog/2018-Bingung-Menghitung-Hpp-Untuk-Bisnis-Jasa-Berikut-Cara-Menghitung-Hpp-Perusahaan-Anda/#:~:Text=Yang%20dimaksud%20dengan%20harga%20pokok,Jasa%2C%20khususnya%20laporan%20laba%20rugi.

Wignjosoebroto, S. (2000). Ergonomi Studi Gerak dan Waktu: Teknik Analisis untuk Peningkatan Produktivitas Kerja. *Surabaya: Guna Widya*, 117–169.

Yan, H., Song, M.-J., & Lee, H.-Y. (2021). A Systematic Review of Factors Affecting Food Loss and Waste and Sustainable Mitigation Strategies: A Logistics Service Providers' Perspective. *Sustainability*, *13*(20), 11374.

Yasni, H. (2021). *Industri Cold Chain Nasional 2020 (Kilas Balik)*. Http://Arpionline.Org/Industri-Cold-Chain-Nasional-2020-Kilas-Balik/.