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JURNAL ILMIAH TEKNIK INDUSTRI ISSN: 1412-6869 (Print), ISSN: 2460-4038 (Online) Journal homepage: http://journals.ums.ac.id/index.php/jiti/index doi: 10.23917/jiti.v17i1.5203 1 A Three-Phased Perishable Inventory Simulation Model with Quality Decrease Consideration Muhammad Faisal Ibrahim 1* , Yunita Siti Mardhiyyah 2, Ahmad Rusdiansyah 3, Meidina Kalse Boer 3, Dana Marsetiya Utama 4 Abstract. This article focuses on simulating a three-phase perishable product inventory system of SMEs selling fresh and processed milkfish.

This research was conducted to simulate a perishable product inventory system to understand and analyze the problems that occur then propose solutions to fix them. The simulation model was developed with ARENA software. The existing condition's simulation results show 162 kg/month waste in fresh fish, 158 pcs/month in processed product A, and 86 pcs/month in processed product B. A model with a product renewal process mechanism was proposed to overcome this problem, and seven improvement scenarios were developed.

The results obtained from the seventh improvement scenario revealed that there was a 100% reduction in fresh fish and processed product B and 94% in processed product A. Besides, there was a saving in need for fresh fish supply of 10 kg/day. In this article, we show how ARENA software can be adapted to simulate inventory system problems effectively. This research method can be applied to investigate various supply system scenarios and their consequences before implementing them in a real system. Keywords: inventory simulation; inventory model; arena; perishable product . Abstrak.

Dalam artikel ini, fokus pada simulasi sistem persediaan produk mudah rusak tiga fase suatu UMKM penjual ikan bandeng segar dan olahan. Penelitian ini dilakukan dengan tujuan mensimulasikan sistem persediaan produk mudah rusak untuk memahami dan menganalisis permasalahan yang terjadi kemudian mengusulkan solusi untuk memperbaikinya. Model simulasi dikembangkan dengan perangkat lunak ARENA, hasil simulasi kondisi eksisting menunjukkan bahwa terdapat limbah 162 kg/bulan pada ikan segar, 158 bh/bulan pada produk olahan A, dan 86 bh/bulan pada produk olahan B.

Model dengan mekanisme proses pembaruan produk diusulkan untuk mengatasi masalah tersebut dan dikembangkan tujuh skenario perbaikan. Hasil yang diperoleh dari skenario perbaikan ke tujuh mengungkapkan bahwa terjadi penurunan limbah 100% pada ikan segar dan produk olahan B dan 94% pada produk olahan A. Selain itu, terjadi penghematan kebuthan pasokan ikan segar sebesar 10 kg/hari. Dalam artikel ini, ditunjukkan bagaimana perangkat lunak ARENA dapat diadopsi untuk mensimulasikan masalah sistem persediaan secara efektif.

Metode dalam penelitian ini dapat diterapkan untuk menyelidiki berbagai skenario sistem persediaan dan konsekuensinya sebelum mengimplementasikannya dalam sistem nyata. Kata Kunci: simulasi persediaan; model persediaan; arena; produk mudah rusak. I. INTRODUCTION 1 Reducing Post Harvest Fish Losses is a major problem in many countries, this happens because of the difficulty in handling a standardized and relatively short lifetime of the perishable product (Janssen, Sauer, Claus, & Nehls, 2018). According 1 1 Department of Logistics Engineering, Universitas Internasional Semen Indonesia, Kompleks PT. Semen Indonesia (Persero) Tbk, Jl.

Veteran, Kebomas, Gresik, Jawa Timur 61122 2 Department of Agro industrial Technology, Universitas Internasional Semen Indonesia, Kompleks PT. Semen Indonesia (Persero) Tbk, Jl. Veteran, Kebomas, Gresik, Jawa Timur 61122 3 Department of Industrial Engineering, Institut Teknologi Sepuluh Nopember, Kampus ITS Sukolilo, Surabaya, Jawa Timur 60111 to Cheke and Ward (1998), every fish distribution system in the world almost certainly has some losses throughout the fish distribution process. Losses can be more severe in some developing countries because the variable causes are less manageable, and resources that can reduce losses are also limited.

There are three general 4 Department of Industrial Engineering, Universitas Muhammadiyah Malang, Jl.Raya Tlogomas No. 246, Tlogomas, Kota Malang, Jawa Timur 65144 * email: faisalibrahim.ie@gmail.com Diajukan: Diperbaiki: Disetujui: Izzhati, dkk. / Identifikasi Kebutuhan Pelanggan Terhadap Ikan Asap.... JITI, Vol.17 (1), Juni 2018, 36 – 45 2 categories of fish losses: physical loss, economic loss, and nutritional loss (Ames, Clucas, & Paul, 1991; Cheke & Ward, 1998). Physical loss is a decrease in fish quality that occurs due to poor handling and processing. On the other hand, the net reduction in the potential income from many fish is economic losses (Abelti, Correspondence, &

Abelti, 2016).

Nutrient loss occurs when there is a decrease in nutritional value or increased fish toxicity (Getu & Misganaw, 2015). Physical losses as the most common in developing countries due to lack of ability in managing perishable product inventory, including the product distribution process. According to FAO (2018), Indonesia was the second-largest country to produce fish in 2016, with average capture being around 6 million tons, second to China, whose average production capacity was 15 million tons.

According to KKP (2015), the value of post-harvest fish losses (PHFL) in Indonesia in 2014 was 35%, or equal to 30 trillion rupiahs. According to studies conducted by Hafner et al. (2012), fresh perishable products such as fruits, vegetables, fish, and meat can only last about 3 to 5 days under certain conditions. One way to reduce the number of losses due to product damage is to do an appropriate perishable product inventory management. Inventory management becomes a vital task for the food industry, decisions when to place an order, and how many orders will significantly affect product waste (S. Nahmias, 2011).

According to Transchel and Hansen (2019), inventory management of perishable products is significantly more complex than durable or non- perishable products. Proper inventory control will be able to increase revenue by cutting costs on a perishable product inventory system. All types of perishable products only have a limited lifetime and will face changes in quality compared to the increase in the product's lifetime (Song & Ko, 2016).

Perishable products will lose value when they reach the end of their lifetime (Agustina, Lee, & Piplani, 2014). Quality degradation will continue to occur until perishable products are not safe for consumption and disposal. According to research conducted by Zhang, Liu, Mu, Moga, and Xiaoshuan (2009), a loss of around 15% will occur due to damage to perishable products due to quality degradation from time to time. Therefore, in perishable product inventory management, inventory reduction due to customer demand is essential, but product damage is also a relevant variable.

Based on studies conducted by Shin, Lee, Ryu, Cho, and Son (2019), renewability is another way to increase the lifetime of a perishable product. With renewability, perishable product inventory is more controlled so that it can reduce wasted products. At present, renewability in a company will make cost savings, but certainly by not reducing the quality of products sold. Not infrequently, several products in one company can be produced by renewing the previous product phase and primary raw materials. Small and Medium-sized Enterprises (SMEs) X selling fresh and processed milkfish products be the object of this research. The business sells three main products: fresh milkfish, presto milkfish, and shredded milkfish.

In the current real system condition, producing all processed products using primary raw materials, namely, milkfish purchased from suppliers, so that all products have their raw material inventory. An exclusive interview explained that the product in the previous phase could be used to produce the product in the next phase (with different production methods according to the material being processed). So in this study, a simulation model designed to describe the entire system and its effects will be analyzed. Also, an analysis of the renewal process can minimize the use of raw materials and wasted products.

There have been many inventory models for perishable products in previous studies, but very few consider the renewal process. Several previous studies on perishable inventory models that consider pricing have been carried out by (Al-Amin Khan, Shaikh, Konstantaras, Bhunia, & Cárdenas-Barrón, 2020); N. Chakraborty, Mondal, and Maiti (2013); (X. Chen, Pang, & Pan, 2014; Dalfard, Nosratian, & Applications, 2014; C.-Y. Dye, 2020; Hendalianpour, 2020; Singh & Vishnoi, 2013).

Consideration regarding uncertainty demand has also been made by Chao, Gong, Shi, and Zhang (2015); (Guchhait, Maiti, & Maiti, 2013; Przemyslaw Ignaciuk & Bartoszewicz, 2012; Janssen et al., 2018; Ji et al., 2020; Soysal, Bloemhof-Ruwaard, Haijema, & van der Vorst, 2015). Models with consideration of pricing and promotion have been carried out by Z. Chen (2018). On the other hand, models with considerations of uncertain lifetime and lead time have also been implemented Kouki, Jemai, Sahin, Jurnal Ilmiah Teknik Industri p-ISSN 1412-6869 e-ISSN 2460-4038 3 and Dallery (2014); (Transchel & Hansen, 2019).

The only previous research that developed a perishable product inventory model with renewability considerations was carried out by Shin et al. (2019). The model in this study is a mathematical model, not a simulation. This problem is very complex, so the simulation approach was chosen in this study. The Arena software utilized to simulate existing conditions and when the renewal process was implemented. The reason for using this software is because of its flexibility and easily applied to other research objects. This research's main objective is to study the effect of the implementation of the renewal process on the perishable product inventory model.

Because of the frequent damage to raw materials and finished products due to a decrease in quality throughout the lifetime of the goods, the question arises whether the renewal process strategy can increase inventory management of perishable products. In this study, the investigation focused on the effect of renewal processes on SMEs X revenue. It is related to the number of wasted perishable products due to damage before being processed (raw materials) or sold (finished products). II. LITERATURE REVIEW Over the past two decades, research on inventory management for perishable products is in high demand (Bakker, Riezebos, & Teunter, 2012; Janssen, Claus, & Sauer, 2016; Sharma, 2016).

Perishable products have a short lifetime, and action is needed to accelerate the level of sales and inventory turnover. Pricing and markdown strategies are used to trigger the desire to buy to consumers. According to Amorim, Günther, and Almada-Lobo (2012), costs incurred due to damaged products are considered to achieve cost minimization of the perishable product supply chain. Researches conducted by Z. Chen (2018) Chang, Cheng, and Ouyang (2015), C.-Y. Dye and Yang (2016), P. Mahata, Gupta, and Mahata (2014), G. C. Mahata (2015), X. Chen et al. (2014), Chew, Lee, Liu, Hong, and Zhang (2014), Liu, Zhang, and Tang (2015), Avinadav, Herbon, and Spiegel (2013), C.-J.

Chung, Wee, Chen, and Modelling (2013), Dalfard et al. (2014) raised the issue of price determination problem in the perishable inventory model. The optimal ordering policy for perishable products with the announced price increase conditions has been developed by (Ouyang, Wu, Yang, & Yen, 2016). In general, companies can provide discounts to increase market sales. In addition to competing in the market, price discounts are also closely related to excess stock. Minimization of food spoilage and retailer profit maximization can be done through pricing based on the shelf life of food (Wang & Li, 2012).

The problem of a price reduction or discount on perishable products is studied in Wang and Li (2012), Muniappan, Uthayakumar, Ganesh, and Engineering (2016), W. Chung, Talluri, and Narasimhan (2015), Kuthambalayan, Mehta, and Shanker (2015), Chew et al. (2014), N Chakraborty, Mondal, Maiti, and Engineering (2013). In more complex cases, the optimal discount quantity for multi-item perishable products has been determined in Makkar, Jha, and Sciences (2012). The number of discounts in some instances can also be temporary. The EOQ inventory model for perishable products with a temporary discount quantity has been successfully developed (Taleizadeh, Mohammadi, Cárdenas-Barrón, & Samimi, 2013).

The perishable product inventory model developed by C.-Y. Dye and Hsieh (2013), Herbon (2018) managed to accommodate the two-phase pricing problem. A joint inventory control and pricing model for perishable products with the consideration of delay in payment has been developed by Maihami, Abadi, and Modelling (2012), Soni, Joshi, and Engineering (2013), P. Mahata et al. (2014). Nearly half of the reviewed literature has a model that allows for shortages in the perishable product inventory system. If the supply of a product is smaller than its demand, there can be a backorder or lost sales of some requests that are not met.

Some previous studies that consider backorder in perishable product inventory models are Molana, Davoudpour, and Minner (2012), Kouki et al. (2014), Olsson (2014), Sazvar, Baboli, and Jokar (2013), Singh and Vishnoi (2013). Previous research conducted by Chao et al. (2015), X. Chen et al. (2014), Kouki, Jemaï, and Minner (2015), Olsson (2014), Ramadhan, Simatupang, and Sciences (2012), Shukla and Jharkharia (2014) have also considered lost sales in the perishable product inventory model.

On the other hand, the level of customer service in a Izzhati, dkk. / Identifikasi Kebutuhan Pelanggan Terhadap Ikan Asap.... JITI, Vol.17 (1), Juni 2018, 36 – 45 4 fresh food industry case study is essential for the continuity of product demand. Some previous studies that consider customer service level in the perishable product inventory model are Duong, Wood, and Wang (2015), C.-Y. J. O. Dye (2013), Przemyslaw Ignaciuk and Bartoszewicz (2012), Przemyslaw Ignaciuk, Bartoszewicz, and Engineering (2012), Xiao and Xu (2013), Soysal et al. (2015). J.

Chung and Li (2013) examines the impact of pricing strategies on customer satisfaction and customer behavior on perishable products. Based on the inventory issue policy problem, first-in-first-out (FIFO) and last-in-first-out (LIFO) policies are the most common to use. In the FIFO policy, the oldest item will be used first. Whereas on LIFO, the oldest items will be used last. According to Steven Nahmias (1982), FIFO policies are often optimal, especially in perishable product inventory systems.

The perishable product inventory model with the consideration of three depletion policies (FIFO, LIFO, and random retrieval (RR) have been developed by Shukla and Jharkharia (2014). Regarding the production and product lifetime, the quality of the perishable product decreases during its lifetime. However, it can also be a faulty product when it is produced and damaged early. Previous research on perishable product inventory models by considering rework process or remanufacturing has been carried out by Guchhait et al. (2013), Li, Chan, Chung, and Tai (2015), Muniappan et al.

(2016), Singh and Saxena (2013), Tai and Engineering (2013), Wee and Widyadana (2013), Widyadana and Wee (2012). However, only one previous study by Shin et al. (2019) considers the renewal process. Shin et al. (2019) researched perishable kimchi products, which are daily consumption snacks with complex supply and inventory problems. To prevent price fluctuations, special processes for products are needed before storing them. The way to do this is by salting, with this process proving to be a longer product storage period. In the renewal process, the product's previous phase can be used as raw material for the next phase. So the risk of wasted products will be minimized.

Whereas in the rework process, the product will only be reworked or remanufactured to remain the product itself. According to Ali, Nagalingam, and Gurd (2018), perishable products must run along the refrigerated supply chain to maintain their value. Besides, the temperature must also be controlled to extend or maintain the lifetime of fresh products. Logistics disruptions in food supply can cause food waste, which will cause food shortages and economic losses. These logistical disruptions, such as long transit times, rapidly changing quality, and shorter product life, are the company's problems (Ali et al., 2018). III.

PROBLEM DESCRIPTION Inventories of perishable products are generally discarded after exceeding their useful life because it is no longer suitable for use, or in this case, it is not ideal for consumption. There are several types of perishable product inventory models commonly used, according to Shin et al. (2019). The single-phased model is the most common inventory system, and this inventory system does not consider renewal processes. The single-phase inventory model's primary concern is controlling inventory levels in the specified storage period, so there is no excess and shortage. Another perishable product inventory model is a two-phase inventory model.

In this inventory model, there is an inventory of perishable products in phase 1 and phase 2. Inventories in phase 1 will enter the renewal process to be converted into phase 2 inventories, and the process will extend the lifetime of the Supplier Producer : Fresh Material Flow : Renewal Flow : Finishgood Flow Product A Product B Product C Customer Figure 1. General description of the system. Jurnal Ilmiah Teknik Industri p-ISSN 1412-6869 e-ISSN 2460-4038 5 inventory.

However, the renewal process will incur additional costs, so it is also necessary to consider the trade-off costs that arise with their customer demand benefits. So it is required to determine whether renewal must be done or not and when it must be done. In this case study, the renewal process's decision will be the main problem and is followed by when it has to be done and how many inventories will be renewed. In contrast to previous studies, this study's problems become more complicated because there are 3 phases of inventory. SMEs X is one of the producers of processed milkfish products and a retailer of fresh milkfish.

Processed fish products produced by SMEs X include presto milkfish and shredded milkfish. In producing presto milkfish products, raw materials can be in the form of fresh milkfish from suppliers or fresh milkfish in stock at retail sales. Milkfish shredded products can be produced using raw milkfish from suppliers or fresh milkfish in stock at retail sales. Besides, shredded production can also use raw material stock of Presto milkfish with the process's addition. To meet consumer demand, SMEs X must have inventory for these three products. If it cannot meet consumer demand, there will be a lost sale that is detrimental to the SMEs X, a general picture of the system can be seen in Fig 1.

The purpose of developing this simulation model is to analyze the effect of renewal process policies on SMEs X perishable product inventory system. In phases two and three, products can be produced using products in the previous raw material phase from suppliers. It will be analyzed whether the policy can minimize costs and maximize SMEs X revenue. Higher profits will be achieved by reducing lost sales and lower inventory costs. IV. MODEL DEVELOPMENT Arena software used in the system simulation described earlier.

The output to be analyzed is the amount of product wasted from fresh milkfish, presto milkfish, and shredded milkfish. The layout of the model divided into six parts: (1) fresh fish arrival and storage from supplier, (2) demand fulfillment, (3) fresh fish handling and storage, (4) production and storage of processed fish A, (5) production and storage of processed fish B, (6) inventory aging inspection, has been shown in Fig. 2. Assumption of the simulation model ? Supply quantity is deterministic ? Supply and demand are daily ? Phase 1 product inventory can be directly sold or renewed to phase 2 or 3 product inventory.

? Phase 2 product inventory can be directly sold or renewed into phase 3 product inventory. ? Losses due to process failures and defects are not considered. All inventories that enter the renewal process will be converted into inventories in the next phase. Figure 2. Simulation models by arena software. Izzhati, dkk. / Identifikasi Kebutuhan Pelanggan Terhadap Ikan Asap.... JITI, Vol.17 (1), Juni 2018, 36 – 45 6 ? The time needed to process renewal is one working day. ? If the supply is less than the demand, the demand will be fulfilled by the inventory amount, and the remainder is lost sales.

? If the inventory is less than the production quantity, several inventories are made, and the remainder is lost production. Model Elements Create modules In the model, customers' arrival, fresh fish, the start of production, and aging inventory inspections are described as entities entering the system. The CREATE module is used to simulate the arrival of the entity. In this model, entities per arrival can be changed according to the case scenario being run. Details of each entity and its arrival time are listed in Table 1.

Process modules The case study explained that processing was carried out to produce three different products. The second and third products can be produced using fresh fish from suppliers or stock levels of previous level products (renewal). The production process of each product with various possible scenarios is simulated using the PROCESS module. All Process modules in the model can be seen in detail in Table 2. Decide modules Every customer who arrives will only be served if the arrival time is within the range of customer service time windows and the requested product stock availability.

The DECIDE module is used to simulate the process of checking service hours and inventory at the warehouse. When production time arrives, the module is also used to check raw material inventory in the warehouse. Besides, the DECIDE module is also used to simulate checking expired products and raw materials. Table 3 gives details of all the Decide modules in the model. Separate modules The SEPARATE module in the developed model is used to simulate unit conversions. For example, one kilogram of fresh fish after going through the production process will become three pcs of product A. All Separate modules and their number of duplications are listed in Table 4. Tabel 4.

List of Separate modules Name Type # of Duplicates Separate 23 Duplicate Original 2 Separate 07 Duplicate Original 1 Separate 27 Duplicate Original 2 Separate 08 Duplicate Original 1 Tabel 1. List of the entities Name Entity type Type Expression Units Entities per Arrivals First Creation Demand for Fresh Fish Demand FF Expression 0.5 + WEIB(3.41, 1.68) Minutes 1 1 Demand for Processed Fish A Demand PFA Expression 1.5 + 39 * BETA(1.79, 2.07) Minutes 1 8 Demand for Processed Fish B Demand PFB Expression 20 + 102 * BETA(1.54, 1.4) Minutes 1 8 Arrival of Fresh Fish Fresh Fish Constant 24 Hours 190 5 Start Handling Fresh Fish Start Handling FF Constant 24 Hours 1 5 Start Production for Processed Fish A @Scenario1 PFA Production Start Constant 24 Hours 1 3 Start Production for Processed Fish A @Scenario2 PFA Production Start Constant 24 Hours 1 3 Start Production for Processed Fish B @Scenario1 PFB Production Start Constant 24 Hours 0 8 Start Production for Processed Fish B @Scenario2 PFB Production Start Constant 24 Hours 1 8 Start Production for Processed Fish B @Scenario3 PFB Production Start Constant 24 Hours 1 8 Inspect Inventory Aging IA Inspection Constant 24 Hours 1 8 Tabel 2.

List of processes Name Action Delay type Expression (s) Units Handling Process into Fresh Fish Ready to Sell Seize Delay Release Normal 3, 1 Minutes Production Process PFA @Secenario1 Seize Delay Release Constant 5 Hours Production Process PFA @Secenario2 Seize Delay Release Constant 5 Hours Production Process PFB @Secenario1 Seize Delay Release Constant 6 Hours Production Process PFB @Secenario2 Seize Delay Release Constant 6 Hours Production Process PFB

@Secenario3 Seize Delay Release Constant 6 Hours Jurnal Ilmiah Teknik Industri p-ISSN 1412-6869 e-ISSN 2460-4038 7 Assign modules Each entity that moves in the model will contain specific attribute data. In this model, the ASSIGN module is used to embed attribute data into entities.

For example, demand attribute data are given to each customer, and time data is attached to each stock, both raw material and processed products. ASSIGN module is also used to periodically renew each stock's life until the product is declared damaged or expired. ASSIGN module deals with the amount that can be changed according to the case scenario that is run. The Assign module used in the model in detail is shown in Table 5. Hold modules The HOLD module in this model is used to simulate a storage system.

The stored items are fresh fish from suppliers, fresh fish ready to sell, processed products A, and processed products B. Each item continues to be stored for up to three possibilities: sold, used for production, or discarded due to damage. Because all items stored are easily damaged so it must be checked periodically. All HOLD modules used in this model are waiting for a signal to check the stock's age. The Hold module used in the model and related conditions are shown in Table 6. Tabel 3. List of Decide modules and conditions Name Type If Expression Check FF Stock 2-way by Condition Expression NQ(Fresh Fish Warehose @ready to sell.Queue) >= Demand_FF Check Fresh Fish Stock @not ready to sell 2-way by Condition Expression NQ(Fresh Fish Warehose @not ready to sell.Queue) >= FF Handling Quantity Check Fresh Fish Stock @not ready to sell 2 2-way by Condition Expression NQ(Fresh Fish Warehose @not ready to sell.Queue) >= PFA Production Quantity Check Fresh Fish Stock @ready to sell 2-way by Condition Expression NQ(Fresh Fish Warehose @ready to sell.Queue) >= PFA Production Quantity Check Fresh Fish Stock @not ready to sell 4 2-way by Condition Expression NQ(Fresh Fish Warehose @not ready to sell.Queue) >= PFB Production Quantity Check Fresh Fish Stock @ready to sell 3 2-way by Condition Expression NQ(Fresh Fish Warehose @ready to sell.Queue) >= PFB Production Quantity Check Processed Fish A Stock 2-way by Condition Expression NQ(Processed Fish A Warehose.Queue) >= PFB Production Quantity Check PFA Stock 2-way by Condition Expression NQ(Processed Fish A Warehose.Queue) >= Demand_PFA Check PFB Stock 2-way by Condition Expression NQ(Processed Fish B Warehose.Queue) >= Demand_PFB Check Fresh Fish Expired @not ready to sell 2-way by Condition Attribute 27 Check Fresh Fish Expired @ready to sell 2-way by Condition Attribute 24 Check PFA Expired 2-way by Condition Attribute 32 Check PFB Expired 2-way by Condition Attribute 336 Check Time Windows 2-way by Condition Expression CalHour(TNOW) >= HoursToBaseTime(8) && CalHour(TNOW) <= HoursToBaseTime(15) Check Time Windows 2 2-way by Condition Expression CalHour(TNOW) >= HoursToBaseTime(8) && CalHour(TNOW) <= HoursToBaseTime(15)

Check Time Windows 3 2-way by Condition Expression CalHour(TNOW) >= HoursToBaseTime(8) && CalHour(TNOW) <= HoursToBaseTime(15) Tabel 5. List of Assign modules and condition Name Attribute Name New Value Fresh Fish Order Quantity Demand_FF 0.5 + 4 * BETA(1.12, 2.44) Processed Fish A Order Quantity Demand_PFA 0.5 + GAMM(0.84, 2.21) Processed Fish B Order Quantity Demand_PFB 0.5 + GAMM(0.597, 2.22) Arrival Time of Fresh Fish FF Arival Time TNOW Fresh Fish Handling Quantity FF Handling Quantity 177 Processed Fish A Production Quantity @Scenario1 PFA Production Quantity 13 Processed Fish A Production Quantity @Scenario2 PFA Production Quantity 5 Processed Fish B Production Quantity @Scenario1 PFB Production Quantity 7 Processed Fish B Production Quantity @Scenario2 PFB Production Quantity 3 Processed Fish B Production Quantity @Scenario3 PFB Production Quantity 7 Completion Time of Fresh Fish Ready to Sell FF Completion Time TNOW Completion Time of Processed Fish A @Scenario1 PFA Completion Time TNOW Completion Time of Processed Fish A @Scenario2 PFA Completion Time TNOW Completion Time of Processed Fish B @Scenario1 PFB Completion Time TNOW Completion Time of Processed Fish B @Scenario2 PFB Completion Time TNOW Completion Time of Processed Fish B @Scenario3 PFB Completion Time TNOW Fresh Fish Inventory Aging Update @not ready to sell Age of Fresh Fish @not ready to sell TNOW - FF Arival Time Fresh Fish Inventory Aging Update @ready to sell Age of Fresh Fish @ready to sell TNOW - FF Completion Time PFA Inventory Aging Update Age of Processed Fish A TNOW - PFA Completion Time PFB Inventory Aging Update Age of Processed Fish B TNOW - PFB Completion Time Izzhati, dkk. / Identifikasi Kebutuhan Pelanggan Terhadap Ikan Asap.... JITI, Vol.17 (1), Juni 2018, 36 – 45 8 Signal modules The SIGNAL module is used to simulate when the inventory aging inspection takes place.

At the time of inspection, the SIGNAL module will send a signal related to each storage system to inspect. There is a signal module named "Inventory Aging Inspection Instruction" with a signal value of "3" in the model. Pickup & Dropoff modules The PICKUP and DROPOFF modules are always paired with the pickup and putdown functions. When it has been determined how many items will be taken from the warehouse, then the next will be taken, simulated with the PICKUP module. After taking a certain amount, a number of items will enter the system, simulated with the DROPOFF module. All PICKUP and DROPOFF modules in detail are shown in Table 7. V.

ANALYSIS OF THE EXISTING CONDITIONS In this section, the model is run according to the existing conditions. There were quite some products wasted due to expired, and there were also some lost sales. The results of the simulation of the existing conditions illustrate that perishable product inventory management has not been optimal, causing the product to be damaged before being sold. The simulation results are based on preliminary data that we have obtained. The amount of product wasted per month, respectively: 162kg Fresh Fish (FF), 158kg Processed Fish A (PFA), and 86pcs Processed Fish B (PFB).

In the next step, improvement scenarios will be developed to optimize the inventory system and minimize wasted products. Tabel 6. List of Hold modules Name Wait for Value Queue Name Fresh Fish Warehose @not ready to sell 3 Fresh Fish Warehose @not ready to sell.Queue Fresh Fish Warehose @ready to sell 3 Fresh Fish Warehose @ready to sell.Queue Processed Fish A Warehose 3 Processed Fish A Warehose.Queue Processed Fish B Warehose 3 Processed Fish B Warehose.Queue Tabel 7.

List of Pickup & Dropoff modules Name Quantity Queue Name Pickup Dropoff Pickup Fresh Fish @not ready to sell @completely filled Dropoff 07 FF Handling Quantity Fresh Fish Warehose @not ready to sell.Queue Pickup Fresh Fish @not ready to sell @completely filled 2 Dropoff 09 PFA Production Quantity Fresh Fish Warehose @not ready to sell.Queue Pickup Fresh Fish @ready to sell @completely filled Dropoff 11 PFA Production Quantity Fresh Fish Warehose @ready to sell.Queue Pickup Fresh Fish @not ready to sell @completely filled 4 Dropoff 13 PFB Production Quantity Fresh Fish Warehose @not ready to sell.Queue Pickup Fresh Fish @ready to sell @completely filled 3 Dropoff 15 PFB Production Quantity Fresh Fish Warehose @ready to sell.Queue Pickup Processed Fish A @completely filled Dropoff 17 PFB Production Quantity Processed Fish A Warehose.Queue Pickup FF @completely filled Dropoff 01 Demand_FF Fresh Fish Warehose @ready to sell.Queue Pickup PFA @completely filled Dropoff 03 Demand_PFA Processed Fish A Warehose.Queue Pickup PFB @completely filled Dropoff 05 Demand_PFB Processed Fish B Warehose.Queue Pickup PFB @partially filled Dropoff 06 NQ(Processed Fish B Warehose.Queue) Processed Fish B Warehose.Queue Pickup PFA @partially filled Dropoff 04 NQ(Processed Fish A Warehose.Queue) Processed Fish A Warehose.Queue Pickup FF @partially filled Dropoff 02 NQ(Fresh Fish Warehose @ready to sell.Queue) Fresh Fish Warehose @ready to sell.Queue Pickup Fresh Fish @not ready to sell @partially filled Dropoff 08 NQ(Gudang Ikan Segar.Queue) Gudang Ikan Segar.Queue Pickup Fresh Fish @not ready to sell @partially filled 2 Dropoff 10 NQ(Fresh Fish Warehose @not ready to sell.Queue) Fresh Fish Warehose @not ready to sell.Queue Pickup Fresh Fish @ready to sell @partially filled Dropoff 12 NQ(Fresh Fish Warehose @ready to sell.Queue) Fresh Fish Warehose @ready to sell.Queue Pickup Fresh Fish @not ready to sell @partially filled 4 Dropoff 14 NQ(Fresh Fish Warehose @not ready to sell.Queue) Fresh Fish Warehose @not ready to sell.Queue Pickup Fresh Fish @ready to sell @partially filled 3 Dropoff 16 NQ(Fresh Fish Warehose @ready to sell.Queue) Fresh Fish Warehose @ready to sell.Queue Pickup Processed Fish A @partially filled Dropoff 18 NQ(Processed Fish A Warehose.Queue) Processed Fish A Warehose.Queue VI.

IMPROVEMENT SCENARIOS To overcome the problem of many wasted products, we try to make several improvement scenarios by suggesting a strategic renewal process. The scenario development starts with trying to gradually reduce supply and combine the source of supply in producing a product. Seven improvement scenarios have been developed, which are expected to minimize wasted products and save SMEs X expenses gradually. In detail, the combination of each scenario can be seen in Table 8. In Scenario 1, the supply of FF from the supplier is reduced by 5kg per day and replaces the raw material for making PFB to 5kg PFA with a renewal process.

The supply of FF from suppliers is reduced again in Scenario 2. A reduction in the supply of 2kg per day was carried out together with a reduction in PFA production. In Scenario 3, the PFA production comes from 14kg FF from the supplier and 2kg FF from inventory. It makes the supply of FF from suppliers can be minimized to 191kg per day. In scenarios 4 and 5, gradually, the quantity of PFA used to produce PFB is increased. In Scenario 6, the supply of FF from suppliers per day to produce PFA is reduced again and replaced with FF. The quantity of FF to produce PFB again increased by 1kg per day in Scenario 7.

This Improvement Scenario managed to save 10kg of FF supply every day and significantly reduce the level of wasted products. VII. RESULTS The improved model is run based on the improvement scenario described in the previous sub-chapter. The simulation experiment results are summarized in Table 9. Gradually there was a significant reduction in wasted product savings on all products, even though there was still a small amount of product wasted. An increase in lost sales but not as significant as a decrease in wasted product. In the simulation results of existing conditions, the number of products wasted, especially for fresh fish and processed fish A is very high.

So a gradual improvement scenario is carried out to reduce product wasted and balancing it. Can be seen in Table 8, the best Tabel 8. Improvement scenario Name Scenario 0 1 2 3 4 5 6 7 Create Module (Entities per arrival) Arrival of Fresh Fish 200 195 193 191 191 191 190 190 Start Production for Processed Fish A @Scenario1 1 1 1 1 1 1 1 1 Start Production for Processed Fish A @Scenario2 0 0 0 1 1 1 1 1 Start Production for Processed Fish B @Scenario1 1 0 0 0 0 0 0 0 Start Production for Processed Fish B @Scenario2 0 1 1 1 1 1 1 1 Start Production for Processed Fish B @Scenario3 0 0 0 0 1 1 1 1 Assign Module (New Value) Fresh Fish Handling Quantity 175 177 177 177 177 177 177 177 Processed Fish A Production Quantity @Scenario1 18 18 16 14 14 14 13 13 Processed Fish A Production Quantity @Scenario2 0 0 0 2 3 4 5 5 Processed Fish B Production Quantity @Scenario1 7 0 0 0 0 0 0 0 Processed Fish B Production Quantity @Scenario2 0 5 5 5 2 2 2 3 Processed Fish B Production Quantity @Scenario3 0 0 0 0 4 7

7 7 Tabel 9.

Simulation results Condition FF Supply Quantity per Day (kg) Quantity to be FF (kg) Quantity to be PFA (kg) Quantity to be PFB (kg*) Wasted per Month Lost Sales per Month FF PFA PFB FF PFA PFB Exsisting 200 175 18 7 162 158 86 19 0 0 Supply Supply Supply Scenario 1 195 177 18 5 76 205 0 11 4 0 Supply Supply FF Scenario 2 193 177 16 5 76 43 0 11 7 0 Supply Supply FF Scenario 3 191 177 16 5 20 43 0 11 18 0 Supply Supply=14; FF=2 FF Scenario 4 191 177 17 6 73 12 0 11 18 7 Supply Supply =14; FF=3 FF=2; PFA=4 Scenario 5 191 177 18 9 45 9 0 11 18 7 Supply Supply =14; FF=4 FF=2; PFA=7 Scenario 6 190 177 18 9 17 9 0 11 16 7 Supply Supply =13; FF=5 FF=2; PFA=7 Scenario 7 190 177 18 10 0 9 0 11 16 4 Supply Supply =13; FF= 5 FF=3; PFA=7 *specifically the supply from PFA uses pcs Izzhati, dkk. / Identifikasi Kebutuhan Pelanggan Terhadap Ikan Asap.... JITI, Vol.17 (1), Juni 2018, 36 – 45 10 results are obtained when there is a combination of supply which causes a decrease in wasted product.

Besides, the implementation of the renewal process can also reduce the number of supply from suppliers. In the existing condition, the amount of fresh fish supply per day is 200kg. Improvement scenario succeeded in reducing the supply of fresh fish per day to 190kg; thus, savings can be obtained. When the improvement scenario is run, there is an increase in lost sales. Even so, the increase in lost sales that occurred is still within reasonable limits so that it remains more profitable compared to existing conditions.

Through numerical experiments in this study, companies can reduce waste by periodically renewal processes and put supplies on products that are more durable than fresh products. This study's results can prove that the simulation model can be done in inventory management of perishable products that have never been done before. VIII. CONCLUSION This study discussed the three-phased perishable inventory model with quality decrease consideration. This research's main objective was to develop ARENA simulation model to minimize waste on the perishable inventory system.

Initially, the existing conditions were investigated to portray the system into the ARENA model and know the logic modules needed. They are followed by data collection and determination of distribution. After the model is run, it is found that there are many waste products on fresh fish and processed fish A. Improvement scenarios were developed to suppress product waste numbers. The experimental result showed the best scenario occurs in scenario improvement, and the results showed a 100% decrease in waste of fresh fish and processed fish B. Besides, wasted process fish A is reduced by 94%.

There was an increase in increase in lost sales but not significant. Overall, the renewal process application has successfully reduced the number of supply needs from suppliers and overall product waste. In this simulation model, determining the number of orders and units to be processed is done on a trial and error basis to require a little more computation time. Future research should aim to develop simulation models that are integrated with other decision support system. DAFTAR PUSTAKA Abelti, A., Correspondence, A., & Abelti. (2016).

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