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Determining The Optimal Amount of Bread Production with The Newsboy Problem Method at Adara Bakery and Cake

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Abstract

Adara Bakery and Cake is one of the micro, small, and medium enterprises that focus on bread production. The problem faced by Adara Bakery and Cake is an excess of products due to a production system that uses a continuous process method, which means that bread is produced continuously without considering the products sold. The objective of this study is to determine the optimal production quantity for the 8 most popular types of bread to be produced by Adara Bakery and Cake, as well as to identify the expected profits when production is at the optimal level. This study discusses the optimal production of the 8 most popular types of bread, namely chocolate brownies, pineapple roll cake, chocolate-topped bread, chocolate banana, black forest cake, slice cake, peanut pie, and dessert, using the newsboy problem method. Based on the research results, the optimal production quantity for chocolate brownies is 141 boxes, for pineapple roll cake is 191 boxes, for chocolate bread is 351 packages, for chocolate banana bread is 335 packages, for Black Forest cake is 237 boxes, for slice cake is 239 pieces, for peanut pie is 1, 779 pieces, and for desserts is 159 pieces. The expected profit for chocolate brownies is Rp 1,252,000, for pineapple roll cake is Rp 1,494,900, chocolate bread is Rp 595,800, chocolate banana is Rp 532,000, Black Forest cake is Rp 3,890,000, sliced cake is Rp 535,500, peanut pie is Rp 2,538,200, and dessert is Rp 1,141,000.

Keywords: *Newsboy Problem*, *Single Period Problem*, *Expected Profit*, *Optimum Production*, *Semi-Perishable Product*.

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1. Introduction

The development of food and beverage industry technology has led to increasingly fierce competition between companies [1]. To overcome this competition, every company is required to improve all aspects of its operations to run effectively and efficiently by improving production quality to meet consumer demand [2]. Consumer needs can be met by ensuring product availability through the utilization of all available resources to produce optimal products [3]. To produce optimal products, proper production planning is required [4]. Proper production planning aims to determine the optimal level of sales, production, and inventory [5]. Some products or inventory cannot be stored for long periods or have a short sales period, such as magazines, newspapers, food, and beverages [6]. Bread is a semi-perishable food, which means that this type of food cannot be stored for long periods of time and is prone to spoilage or damage [7].

Adara Bakery and Cake is a business engaged in the production of bread and cakes located on Jalan Medan-Banda Aceh, Batuphat Timur, Muara Satu District, Lhokseumawe City. The problem faced by Adara Bakery and Cake is an excess of products due to its use of a continuous production system. This means that Adara Bakery and Cake produce bread and cakes continuously without considering the products that are sold [8]. Adara Bakery and Cake produces best-selling cakes and bread, including chocolate brownies, pineapple roll cake, chocolate-topped bread, chocolate banana, Black Forest cake, slice cake, peanut pie, and desserts. Based on company data over one year (February 2024 to January 2025), production totaled 42,956 boxes. The number of products sold was 22,746 boxes, resulting in unsold products totaling 19,850 boxes. To address the challenges faced by Adara Bakery and Cake, it is necessary to determine optimal production levels to prevent the accumulation of finished goods, which could lead to wasteful expenses [9].

This study uses the Newsboy Problem method to determine the optimal production quantity obtained from consumer demand probabilities to increase expected profit [10]. The Newsboy Problem, also known as the single period inventory problem [11], is generally used in companies that produce seasonal products such as fashion items and perishable goods [12]. By using the Newsboy Problem method, it is hoped that Adara Bakery and Cake can determine the optimal production quantity for each type of bread and cake in order to maximize profits [13].

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2. Research Methods

2.1. Data Collection Methods

The data collection method interprets the data by the purpose, design, and nature of the study [14]. The data collection techniques used in this research are as follows:

1. Direct Observation
   Going to the field to make sure the information gathered is relevant to the information data is known as direct observation of the object [15].
2. Interview
   Unstructured interviews, also known as free interviews, are those in which the researcher merely highlights key points regarding the concerns to be gathered without following interview protocols that specify questions to ask. The owners and staff of Adara Bakery and Cake were interviewed for this study to get the required data [16].
3. Documentation Study
   Documentation studies are conducted to document information relevant to the research being conducted to gather data for use in the study [17].
4. Literature Study
   Theories derived from the utilization of published sources such as books, journals, websites, and so forth that bolster the conducted study are known as literature studies [18].

2.2. Newsboy Problem Methods

Orders for perishable goods, such as fruits, vegetables, seafood, or other items with a short shelf life, like newspapers and magazines, are typically handled by the Newsboy Problem [19]. The product kinds are occasionally offered at inexpensive prices or may also be associated with expenses for items that spoil quickly if they are not used or do not sell effectively [20]. The two costs that are typically the focus of single-period analysis are excess and lost sales [21]. Costs associated with missed opportunities or lost buyers are examples of lost sales.

One model that considers the degree of unpredictability in the quantity of requests received during each production cycle is the Newsboy model. Chen Feder Gruen created the Newsboy model, in which profit is represented by the mean and risk by the variance, or departure from the mean [22]. In addition to examining the products' expiration date, the sales figures of the products also reveal the products' age. The object in question is still within the time limit if it can be sold for a regular price [23]. The Newsboy model's primary goals are to ascertain the ideal production level that yields the highest profit and forecast the size of the profit variation that will occur [24]. The formula used in the newsboy problem method is as follows:

1. If demand (D) is greater than the number of products sold (Q), then the seller can sell all products and earn a profit of Q x (SP-UC)
2. If demand (D) is less than the quantity sold (Q), then the seller can only sell the quantity demanded (D) at full price and obtain the surplus value (SV) of each Q-D, so the profit is:
   EP (Q) = D x SP (Q-D) x SV – Q x UC (1)
   Where:
   EP (Q) = Expected profit at production quantity Q
   SP = Selling Price
   Q = Production quantity
   D = Quantity demanded
   SV = Scrap Value
   UC = Unit Cost

   The profit from optimal production quantity (Q) or EP (Q) will generate expected profit, which is calculated using the formula:
   $EP(Q) = SP \times [\sum_{D=0}^{Q} D \times prob(D) \times Q \times \sum_{D=Q+1}^{Q} prob(D)] - Q$ (2)

   The profit from the optimal production quantity (Q) that generates the expected profit, calculated using the formula:
   EP (Q) = *expected profit – expected cost* (3)

   The optimal sales quantity for a company with scrap value can be calculated using the formula:
   $Prob(D \geq Qo) > \frac{UC-SV}{SP-SV} > prob(D \geq Qo + 1)$ (4)

3. Results

Processing the data and analyzing the outcomes come next after the data has been collected. The following are the study's findings and conclusions:

3.1. Unit Cost Data

The cost per unit of Adara Bakery and Cake items produced in June 2025 is the unit cost information that was acquired from the business's owner. The selling price positively rises in tandem with the unit cost. Only the eight most popular varieties of Adara Bakery and Cake bread are included in this unit cost data, as listed in Table 1 below:

Table 1. Unit Cost Data in Rupiah Units

Types of Bread	Selling Price (Rp)	Unit Cost (Rp)
Chocolate brownies	40.000	28.000
Pineapple roll cake	33.000	23.100
Chocolate topping bread	6.000	4.000
Chocolate banana	6.000	4.200
Black forest cake	55.000	30.000
Slice cake	15.000	10.500
Peanut pie	3.000	1.700
Desserts	15.000	8.000

3.2. Cumulative Probability of Chocolate Brownies

The following explains how to calculate the probability of sales and the cumulative probability of chocolate brownies, which can be seen in Table 2 as follows:

Table 2. Cumulative Probability Of Chocolate Brownies

Production	Sales	Probability Sold	Probability Sold/Total	Cumulative Probability
159	121	0,761	0,081	0,081
154	128	0,831	0,087	0,168
143	112	0,783	0,082	0,250
139	127	0,913	0,097	0,347
141	119	0,843	0,089	0,436
168	124	0,738	0,078	0,514
159	125	0,786	0,082	0,596
151	126	0,834	0,089	0,685
166	127	0,765	0,080	0,765
161	110	0,683	0,072	0,837
149	116	0,778	0,083	0,920
157	119	0,757	0,080	1
Total	**1.454**	**9,476**	**1**	

When the production and sales quantities are equal, the sales quantity is collected, and the sales quantity is divided by the production quantity to determine the likelihood of being sold. The overall value of each manufacturing unit is then calculated by adding up all the results. Each production unit has a total value of one. The results of each manufacturing unit are divided by the sum of the results of all the production units to determine the likelihood that chocolate brownies will be sold.

The method for calculating the cumulative probability value (Table 4.2) for a production quantity of 159 is as follows:

Production Amount : 159 boxes

Sales Amount : 121 boxes

$$\frac{\text{Production Amount}}{\text{Sales Amount}} = \frac{121}{159} = 0{,}761$$

The total of all probability outcomes sold is 9.476. The way to calculate the probability sold/total for a production quantity of 159 is:

$$\frac{0{,}761}{9{,}746} = 0{,}081$$

In the meantime, cumulative probability is computed by summing the probability of the previous manufacturing unit's sale with the cumulative probability of that unit. The likelihood of production unit 154, for instance, is:

0,081 + 0,087 = 0,168

3.3. Optimal Production Quantity of Chocolate Brownies

Finding the ideal production amount of chocolate brownies comes next, after the cumulative likelihood and sale probability have been established. Chocolate brownies cost Rp 28,000 per unit, and they sell for Rp 40,000. Brownies will be sold at a 50% discount of Rp 20,000 if none are sold by 9:00 PM. Formula number 4 in Chapter II is used to determine the ideal production quantity, and it is as follows:

$$\text{Prob } (D \geq Qo) > \frac{UC\text{-}SV}{SP\text{-}SV} > \text{prob } (D \geq Qo + 1)$$

$$\text{Prob } (D \geq Qo) > \frac{28.000\text{-}20.000}{40.000\text{-}20.000} > \text{prob } (D \geq Qo + 1)$$

Prob (139) > 0,4 > prob (141)

Prob (0,347) > 0,4 > prob (0,436)

According to the newsboy problem calculation, 141 boxes of chocolate brownies are the ideal production amount. Under these ideal circumstances, the most profitable production amount is 141 boxes. By employing the ideal production amount, Adara Bakery and Cake can maximize their revenues while minimizing the value of unsold chocolate brownies. Because Adara Bakery and Cake can satisfy customer demand, the ideal manufacturing amount can reduce the cost of missed sales.

3.4. Expected Profit of Chocolate Brownies

The projected optimal expected profit that Adara Bakery and Cake can make can be ascertained by applying the newsboy problem method to find the ideal production amount. Formula number 1 in chapter 2 can be used to get the projected profit, which is as follows:

Unit Cost (UC)	= Rp 28.000/box
Selling Price (SP)	= Rp 40.000/box
Scrap Value (SV)	= Rp 20.000/box
Sales (D)	= 119 box/month
Production (Q)	= 141 box/month

EP (Q)	= D x SP + (Q-D) x SV – Q x UC
EP (141)	= 119 x 40.000 + (141 - 119) x 20.000 – 141 x 28.000
EP (141)	= Rp 1.252.000

The estimated profit calculation is Rp 1,252,000, while the actual profit obtained from chocolate brownies is Rp 812,000. So, by using the newsboy problem method, Adara Bakery and Cake will get an increase in profit of Rp 440,000.

3.5. Adara Bakery and Cake Profit Differences

The difference in profits for Adara Bakery and Cake before and after implementing the newsboy problem method can be seen in Table 3 as follows:

Table 3. The Difference in Profit Obtained

Types of Bread	Before (Rp)	After (Rp)
Chocolate brownies	812.000	1.252.000
Pineapple roll cake	1.098.900	1.494.900
Chocolate topping bread	559.800	595.800
Chocolate banana	394.000	532.000
Black forest cake	1.855.000	3.890.000
Slice cake	445.500	535.500
Peanut pie	763.700	2.538.200
Desserts	721.000	1.141.000

Total	**6.649.900**	**11.979.400**

There's a noticeable difference between Adara Bakery and Cake employing the newsboy problem approach and when they do not, which is Rp 5,329,500, as shown in the above table. The profit graph obtained by Adara Bakery and Cake can be seen in Figure 1 as follows:

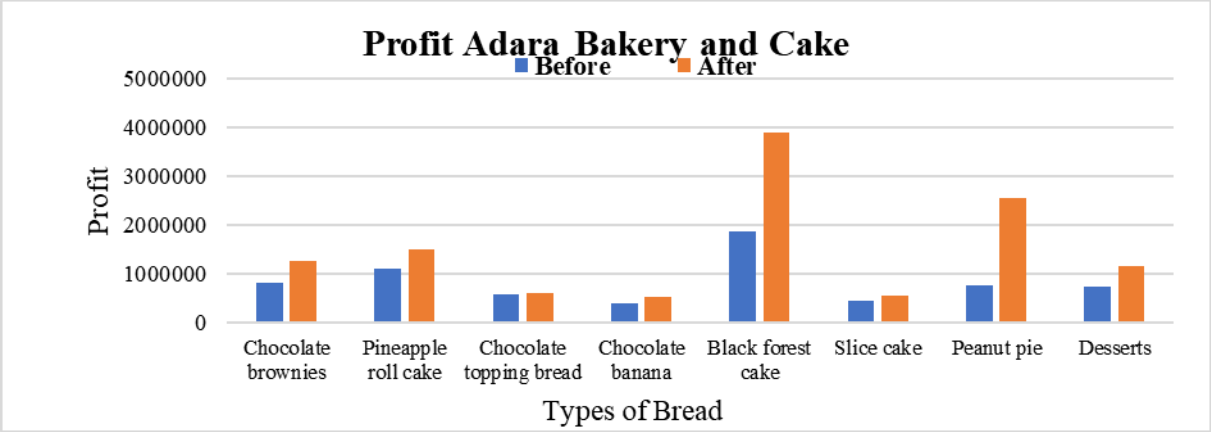

Figure 1. Adara Bakery and Cake Profit Differences

4. Conclusion

The following are the outcomes of applying the newsboy problem method to the eight most popular varieties of Adara Bakery & Cake bread:

1. The optimal production quantity for Adara Bakery and Cake's chocolate brownies is 141 boxes, with an expected profit of Rp 1,252,000, while the actual profit obtained from chocolate brownies is Rp 812,000. This means that there is a significant difference for Adara Bakery and Cake when using the newsboy problem method and when not using the newsboy problem method, namely Rp 440,000.
2. The optimal production quantity for Adara Bakery and Cake's pineapple roll cake is 191 boxes, with an expected profit of Rp 1,494,900, while the actual profit obtained from pineapple roll cake is Rp 1,098,900. This indicates a significant difference between Adara Bakery and Cake when using the newsboy problem method and when not using it, amounting to Rp 396,000.
3. The optimal production quantity for Adara Bakery and Cake's chocolate-topped bread is 351 packages, yielding an expected profit of Rp 595,800, while the actual profit obtained from chocolate-topped bread is Rp 559,800. This indicates a significant difference for Adara Bakery and Cake when using the newsboy problem method compared to not using it, amounting to Rp 36,000.
4. The optimal production quantity for Adara Bakery and Cake's chocolate banana product is 335 packages, with an expected profit of Rp 532,000, while the actual profit obtained from the chocolate banana product is Rp 394,000. This means that there is a significant difference for Adara Bakery and Cake when using the newsboy problem method and when not using the newsboy problem method, namely Rp 138,000.
5. The optimal production quantity for Adara Bakery and Cake Black Forest cake is 237 boxes, yielding an expected profit of Rp 3,890,000, while the actual profit obtained from Black Forest cake is Rp 1,855,000. This indicates a significant difference between Adara Bakery and Cake when using the newsboy problem method and when not using it, amounting to Rp 2,035,000.
6. The optimal production quantity for Adara Bakery and Cake for slice cakes is 239 pieces, yielding an expected profit of Rp 535,500, while the actual profit obtained from slice cakes is Rp 445,500. This means that there is a significant difference for Adara Bakery and Cake when using the newsboy problem method and when not using the newsboy problem method, namely Rp 90,000.
7. The optimal production quantity for Adara Bakery and Cake's peanut pies is 1,779 pieces, yielding an expected profit of Rp 2,538,200, while the actual profit obtained from peanut pies is Rp 763,700. This indicates a significant difference between Adara Bakery and Cake when using the newsboy problem method and when not using it, amounting to Rp 1,774,500.
8. The optimal production quantity for Adara Bakery and Cake desserts is 159 pieces, with an expected profit of Rp 1,141,000, while the actual profit obtained from desserts is Rp 721,000. This means that there is a significant difference for Adara Bakery and Cake when using the newsboy problem method and when not using the newsboy problem method, namely Rp 420,000.

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