Production Strategy to Anticipate Peak Demand to Achieve Maximum Profits

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ABSTRACTS
This paper contains an alternative daily production plan strategy to anticipate peak demand on online national shopping day. There are four alternative strategies presented in this paper, the first is the level strategy, chase strategy, mix strategy and **adjusted mix strategy as a result of the author's development**. The criteria used are profits that can be achieved for 2 weeks. The analysis was carried out for a period of two weeks (a week before and after) the peak day. The company that is the object of this problem is a garment company in the city of Bandung with the trademark 'Sipolos'. The costs involved in this analysis are only some of the costs recommended by the company, namely costs associated with increasing production that are feasible to apply and costs for losses due to shortages (lost sales). Of the four strategies simulated, the adjusted mix strategy developed by the author provides the best solution, providing greater profits than other strategies of more than 20%.

Keyword: Daily production, inventory, lost sale, subcontract, profit.

1. Introduction

Industrial development in Indonesia has increased very rapidly along with the increasing needs and current population growth. [1] One type of industry that is experiencing rapid development is the clothing industry (Binus University, 2019). Thus, all clothing industries are required to be able to make changes to the best strategy according to market needs that often change dynamically. [2] The amount of market demand that is always changing (Ren, S., Chan, 2020) makes all clothing industries must be able to plan production in a precise and structured manner to be able to meet market needs without losing the opportunity to get maximum profit but not ignoring the buildup or excess stock. [3] Market demand fluctuates every day, especially at certain times, for example during religious holidays, national holidays or national shopping days (Giri, C., & Chen, Y, 2022).

[4] One of the companies that produces clothing with the trademark "Sipolos" is currently often faced with soaring demand, namely during Harbolnas or National Online Shopping Day (Putri,et.al, 2023). The increase in demand before Harbolnas day was very significant starting from D-2, and when it passed D+1, D+2 there was a significant decrease as well. This situation makes it difficult for the company to determine the right level of production. If the company does not anticipate this situation, there will usually be a supply shortage, meaning that the company cannot take advantage of opportunities to get maximum profit from sales. On the other hand, if the company produces in too large a quantity, it will result in overstocking, especially when demand has started to decline, namely at D+1, D+2 and so on.

At this time 'Sipolos' sells through e-commerce such as Shopee, Lazada and so on. The difficulty faced was when facing 4 major Harbolnas events, namely 9.9 meaning September 9, 10.10 meaning October 10, and so on 11.11 and 12.12, including Eid al-Fitr. The phenomenon that occurs is that on those days there is always an increase in sales, even shortages often occur. [5] This pattern is repeated every year, because the majority of consumers know that on those days there are often big enough discounts so that demand at that time increases sharply (Prayitno, S. B., 2023). To meet market needs, the company implements a production strategy by maximizing existing capacity and a subcontracting policy with limited quantities. The following is the demand data for one week before and after Harbolnas.

Table 1. Demand (pcs) during Harbolnas 2023

Day	9.9	10.10	11.11	12.12
D-6	184	201	219	177
D-5	252	369	225	213
D-4	201	336	180	309
D-3	252	345	171	174
D-2	282	339	183	222
D-1	249	333	180	222
Peak Day	5.668	2.992	4.576	5.474
D+1	768	420	610	693
D+2	294	336	383	420
D+3	255	390	213	429
D+4	261	408	329	291
D+5	408	351	391	258
D+6	234	324	337	273

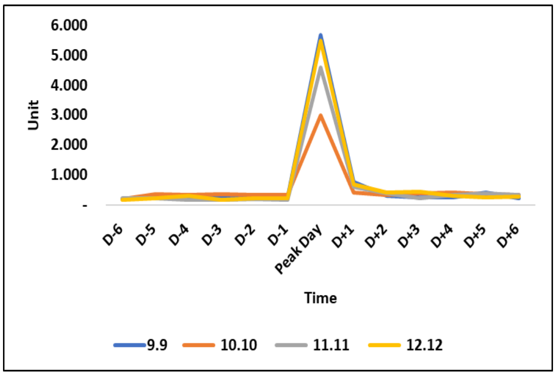

Figure 1. Demand curve for two weeks

On that basis, the researcher tries to convey several alternative production strategies to anticipate peak demand, by developing existing strategies to obtain better results. The researcher hopes that this article can help provide additional references to decision makers in companies and to students in general

2. Review Literature

The material used as the material for this paper is taken from a case study that occurred in the 'Sipolos' garment company located in the city of Bandung, Indonesia. The problem is how to make a daily production plan to anticipate peak demand to maximize profit. The method used is the aggregate planning method with four strategies used, namely: Chase Strategy (Chase Demand), Level Strategy, Mixed Strategy and Adjusted Mixed Strategy (Gansterer, M., 2015)[6]. Adjusted mix strategy is the result of **the researchers' development** in this paper. Based on the reference, there are three strategies that can be used in aggregate planning, namely 1. Chase strategy (chase demand) which is a strategy used to achieve production levels in accordance with demand for each period to minimize inventory. The characteristics of this strategy are adjusting the level of production with the level of demand, adding or reducing labor according to the level of demand and the number of permanent workers, with variable working hours (Buxey,2003) [7]. 2. Level Strategy (Level Production) is a strategy taken by maintaining a constant level of production capacity or output, and a constant workforce. The characteristics of this strategy is to maintain a constant level of production and allow inventory levels, shortages or lost sales to occur (Türkay, M., 2021)[8]. 3. Mixed Strategy is a strategy combination between level strategy and chase strategy. The characteristics of this strategy is to determine the level of production to anticipate the level of demand by tolerating the existence of supplies or shortages or lost sales (Jamalnia, 2017)[9]. In this method any 'feasible alternative' to increase capacity can be done such as subcontracting, working overtime or perhaps adding work shifts. In essence, this method is a combination of the level method and the chase strategy. Mix strategies are oriented towards finding the best solution to maximize profit or minimize costs (usually using linear/integer programming). In this research the author used several other references which were used as comparison material. These references include; [9] Jamalnia, A., Yang, J. B., Xu, D. L., & Feili, A. (2017). Novel decision model based on mixed chase and level strategy for aggregate production planning under uncertainty: Case study in beverage industry. *Computers & Industrial Engineering*, *114*, 54-68. The paper proposes a decision-making model for aggregate production planning based on mixed and level strategies under uncertainty where demand is the main source of uncertainty. The model built is stochastic, nonlinear, multistage and multiobjective. Therefore, this model involves various objectives such as total revenue, total production costs, total labor productivity costs, optimal utilization of resources and production capacity, and customer satisfaction, and is then validated based on real-world data from the beverage manufacturing industry.

[10] Oey, E., Wijaya, W. A., & Hansopaheluwakan, S. (2020). Forecasting and aggregate planning application–a case study of a small enterprise in Indonesia. *International Journal of Process Management and Benchmarking*, *10*(1), 1-21. This research is a case study of a small company in Indonesia, which started as a small family-owned company by utilizing demand forecasting methods and simple supply and demand theory to increase its productivity. This case study tests seven forecasting tools for predicting future demand and implementing aggregate planning strategies.

[11] BUXEY, G. 1993, Production Planning and Scheduling for Seasonal demand, international Journal of Operation and Production Management. In this paper, the author uses aggregate planning to deal with seasonal demand.

[12] Rich Metters, General rule of production Planning with seasonal demand, This paper contains general rules in making aggregate planning, especially to deal with seasonal demand.

[13] Aboozar Jamalnia, Jian-Bo Yang, Dong-Ling Xu, Ardalan Feili, A novel decision model based on mixed chase and level strategy for aggregate production planning under uncertainty: case study in beverage industry, Computers and Industrial Engineering (2017) , doi: https://doi.org/10.1016/j.cie.2017.09.044. This paper contains about optimal decision making in production planning using the stochastic non-linear programming method.

For other references, we will not discuss all of them considering the limited space in this article. For more details, see the bibliography.

3. Data and Calculation

Given the limited space in this paper, this paper only discusses the strategy to anticipate peak demand during the Harbolnas event on December 12, 2024. For other days, the same approach can be done. The following is the result of forecasting data from D-6 to D+6 using the single exponential smoothing method with a smoothing value of = 0.3

Table 2. Forecasted demand Desember 12 2024

Days	Forecasted Demand
D-6	177
D-5	188
D-4	224
D-3	209
D-2	213
D-1	216
PD	1793
D+1	1463
D+2	1150
D+3	934
D+4	741
D+5	596
D+6	499

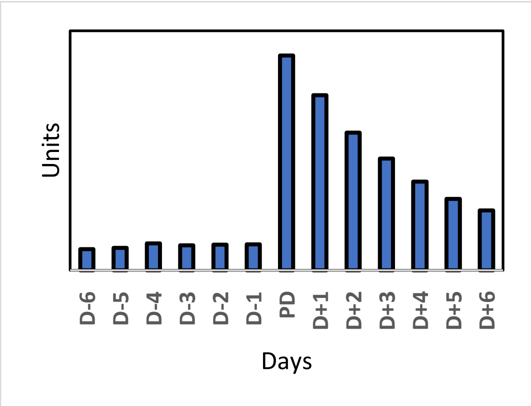

Figure 2. Forecasted demand for one week (before and after) Harbolnas 12 December 2024

Production capacity is calculated based on the speed produced per person of labor per day, which is 90 units per person. The number of workers every day is 5 people, so the maximum production capacity is 450 pcs. per day worked in 1 work shift.

The costs considered include storage costs, subcontract costs, and lost sales costs. For other costs, such as the cost of raw materials and labor costs have been taken into account in determining the cost of production, the cost of goods sold has been represented by the profit per unit. The costs that are calculated are only costs related to the production strategy, namely the costs of increasing production capacity including hiring, firing, overtime and sub-contracts plus storage costs and lost sales costs. Hiring, firing and over time costs are not recommended with the consideration that hiring and firing alternatives have much higher cost consequences. The overtime option also did not get a recommendation with humanitarian considerations, considering that the number of direct workers was very small, namely 5 people.

Based on the calculations that have been done, it is known that the subcontracting fee is IDR. 4500 per pcs, due to a reduction in marginal profit to IDR. 5000 per pcs., with a maximum number of subcontracts of only 300 units. Storage fee IDR. 750 per unit per day, and a lost sale fee of IDR. 9500 per pc. The cost of this lost sale is considered equal to the value of the marginal profit per unit. Initial inventory is set at 250 pcs.

3.1 Strategy 1. Strategy Level

In this strategy the production plan uses a maximum daily production capacity of 450 Pcs. per day, where the production done today will be used to meet the needs of the next day. No sub-contracts and no overtime. Some of the rules used in calculating the table in this strategy are:

P_i : production on day i is used to meet needs on the next day D_{i+1}

Inventory on day i is calculated by the following formula

$$I_i = P_{i-1} + I_{i-1} - D_i \quad (1)$$

Lost sale on the i-th day is calculated by the formula

$$LS_i = D_i - P_{i-1} - I_{i-1} \quad (2)$$

Total profit for two weeks

$$Profit = 9500\sum_{i=1}^{n} D_i - \sum_{i=1}^{n} 750 I_i - \sum_{i=1}^{n} 9500 LS_i$$

The calculation results can be seen in the table below.

Table 2. Profit calculation based on constant production capacity (Strategy Level)

Day	Demand (Pcs)	Cum Demand	Prod Planned (Pcs)	Cum Prod	Inventory (pcs)	Profit (IDR)	Invent Cost (IDR)	Lost Sale (Pcs)	Lost Sale Cost (IDR)
PD			450	450	250		187.500		
D-6	177	177	450	900	523	1.681.500	392.250		
D-5	188	365	450	1.350	785	1.786.000	588.750		
D-4	224	589	450	1.800	1.011	2.128.000	758.250		
D-3	209	798	450	2.250	1.252	1.985.500	939.000		
D-2	213	1.011	450	2.700	1.489	2.023.500	1.116.750		
D-1	216	1.227	450	3.150	1.723	2.052.000	1.292.250		
Peak Day	1.793	3.020	450	3.600	380	17.033.500	285.000		
D+1	1.463	4.483	450	4.050		13.898.500		633	6.013.500
D+2	1.150	5.633	450	4.500		10.925.000		700	6.650.000
D+3	934	6.567	450	4.950		8.873.000		484	4.598.000
D+4	741	7.308	450	5.400		7.039.500		291	2.764.500
D+5	596	7.904	450	5.850		5.662.000		146	1.387.000
D+6	499	8.403				4.740.500		49	465.500
Total	8.403		5.850			79.828.500	5.372.250	2.303	21.878.500

This strategy does not use overtime and sub-contract work so that there is a shortage (lost sale) on the days after peak days. The profit earned is IDR. 52,577,750, namely profit from sales minus storage costs and lost sales costs. In this way there will be a large excess of stock and shortage as in the table above.

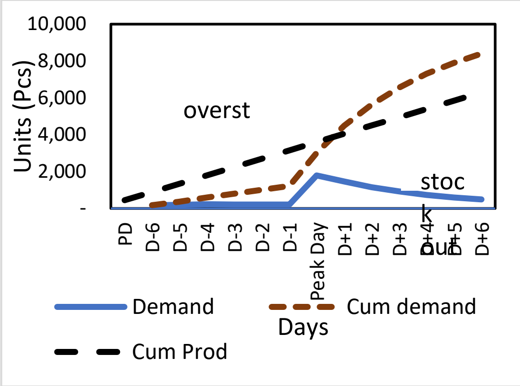

Figure 3. Illustration of when over stock and stock out occur (Strategy Level)

3.2 Strategy 2. Chase strategy

In this strategy, the daily production level plan is adjusted to the demand on the next day. The table calculation rules in this strategy are the same as the calculations in the previous strategy. The difference is the level of production is adjusted to the expected demand in the next period. The production plan for the period D-1 to D+5 uses a maximum capacity of 450 pcs per day, considering that the demand for that period exceeds the maximum production capacity. This strategy has not considered using sub-contracts.

Table 3. Profit calculation based on production capacity according to demand (Chase Strategy)

Day	Demand (Pcs)	Cum Demand	Prod Planned (Pcs)	Cum Prod	Inventory (pcs)	Profit (IDR)	Invent Cost (IDR)	Lost Sale (Pcs)	Lost Sale Cost (IDR)
PD			177	177	250		187.500		
D-6	177	177	188	365	250	1.681.500	187.500		
D-5	188	365	224	589	250	1.786.000	187.500		
D-4	224	589	209	798	250	2.128.000	187.500		
D-3	209	798	213	1.011	250	1.985.500	187.500		
D-2	213	1.011	216	1.227	250	2.023.500	187.500		
D-1	216	1.227	450	1.677	250	2.052.000	187.500		
Peak Day	1.793	3.020	450	2.127		17.033.500		1.093	10.383.500
D+1	1.463	4.483	450	2.577		13.898.500		1.013	9.623.500
D+2	1.150	5.633	450	3.027		10.925.000		700	6.650.000
D+3	934	6.567	450	3.477		8.873.000		484	4.598.000
D+4	741	7.308	450	3.927		7.039.500		291	2.764.500
D+5	596	7.904	450	4.377		5.662.000		146	1.387.000
D+6	499	8.403				4.740.500		49	465.500
Total	8.403		4.377			79.828.500	1.125.000	3.776	35.872.000

The maximum profit achieved is IDR. 42,831,500

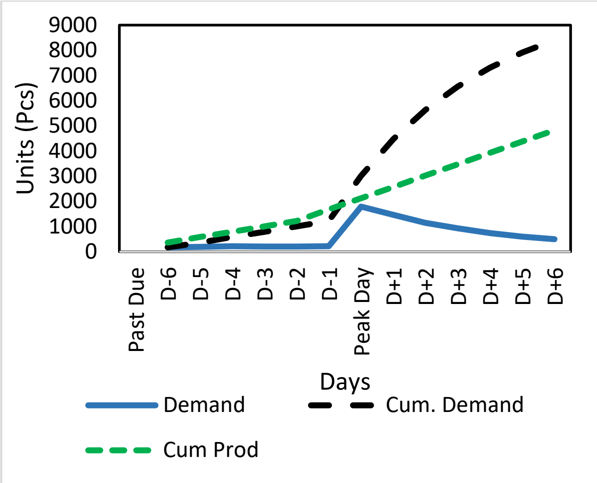

Figure 4. Illustration of the time over stock and stock out occurred (chase strategy)

3.3 Strategy 3. Mix Strategy

In this strategy, production activities use the maximum capacity and the sub-contracts are maximized at 450 and 300 units per day, respectively. Some of the rules used in the calculation of the table in this strategy are the same as the calculations in the previous strategy, except:

Inventory on day i is calculated by the following formula

$$I_i = P_{i-1} + I_{i-1} + S_{i-1} - D_i \quad (3)$$

Lost sale on the i-th day is calculated by the formula

$$LS_i = D_i - P_{i-1} - I_{i-1} - S_{i-1} \quad (4)$$

Table 4. Profit calculation based on maximum capacity and subcontract

Day	Demand (Pcs)	Cum Demand	Prod Planned (Pcs)	Subcontrac (Pcs)	Inventory (Pcs)	Profit (IDR)	Invent Cost (IDR)	Sub Cont Cost (IDR)	Lost Sale
PD			450	300	250		187.500	1.350.000	-
D-6	177	177	450	300	823	1.681.500	617.250	1.350.000	-
D-5	188	365	450	300	1.385	1.786.000	1.038.750	1.350.000	-
D-4	224	589	450	300	1.911	2.128.000	1.433.250	1.350.000	-
D-3	209	798	450	300	2.452	1.985.500	1.839.000	1.350.000	-
D-2	213	1.011	450	300	2.989	2.023.500	2.241.750	1.350.000	-
D-1	216	1.227	450	300	3.523	2.052.000	2.642.250	1.350.000	-
Peak Day	1.793	3.020	450	300	2.480	17.033.500	1.860.000	1.350.000	-
D+1	1.463	4.483	450	300	1.767	13.898.500	1.325.250	1.350.000	-
D+2	1.150	5.633	450	300	1.367	10.925.000	1.025.250	1.350.000	-
D+3	934	6.567	450	300	1.183	8.873.000	887.250	1.350.000	-
D+4	741	7.308	450	300	1.192	7.039.500	894.000	1.350.000	-
D+5	596	7.904	450	300	1.346	5.662.000	1.009.500	1.350.000	-
D+6	499	8.403			1.597	4.740.500	1.197.750	-	-
Total	8.403		5.850	3.900		79.828.500	18.011.250	16.200.000	-

The profit earned is IDR. 45,617,250

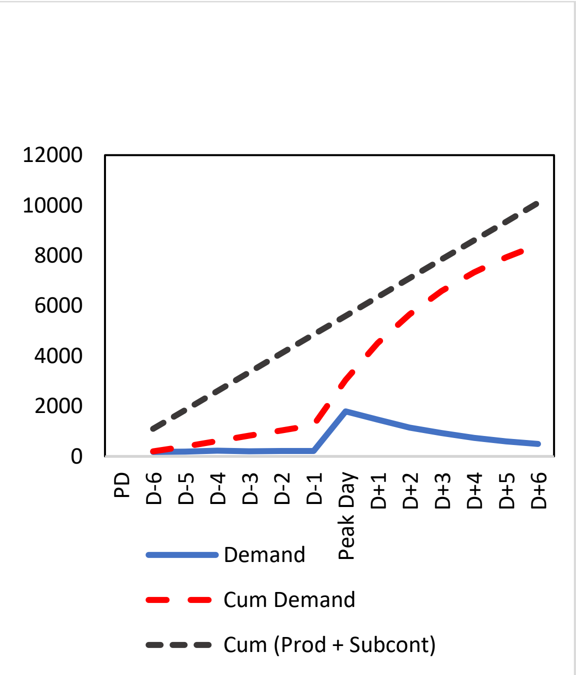

Figure 5. Illustration of when over stock and stock out occur in the mix strategy

3.4 Strategy 4. Adjusted Mix Strategy

This strategy is the result of research development to improve better results from the 3 existing strategies. The formula developed can be seen below. This strategy is used to make improvements from the 3rd strategy in order to get better results by determining subcontracts on a few days to avoid high over stock. The rules used for table calculations are:

For other calculation rules are the same as in the previous strategy.

Inventory on day i is calculated by the following formula

$$I_i = P_{i-1} + I_{i-1} + S_{i-1} - D_i \quad (5)$$

Lost sale on the i-th day is calculated by the formula

$$LS_i = D_i - P_{i-1} - I_{i-1} - S_{i-1} \quad (6)$$

Determining the number of subcontracts is based on the following rule: if S is the size of the subcontract per day, and X is the number of days of subcontracting, then the size of the subcontract to be performed is SX. If the cost of inventory is less than the cost of lost sales, the determination of X is intended to minimize the total lost sale with the following formula,

$$\sum_{i=1}^{n} P_i + S.X + I_0 - \sum_{i=1}^{n} D_i \ ,$$

so the number of days subcontract

$$X = \frac{\sum_{i=1}^{n} P_i + I_0 - \sum_{i=1}^{n} D_i}{S} \quad (7)$$

Based on the above formula, the number of subcontact days is

X = (5850 + 250 - 8403)/300=7.67 rounded up to 7 or 8 days.

To determine the start day of subcontracting, it is determined by

$$(i = n) - 7 = 13 - 7 = 6$$

Therefore, the subcontracting starts for period D - 1. The calculation results can be seen in the following table.

Table 5. Profit calculation with adjusted mix strategy

Day	Demand (Pcs)	Cum Demand	Prod Planned (Pcs)	Subcontrac (Pcs)	Inventory (Pcs)	Profit (IDR)	Invent Cost (IDR)	Sub Cont Cost (IDR)	Lost Sale (Pcs)	Lost sale cost (IDR)
PD			450		250		187.500			
D-6	177	177	450		523	1.681.500	392.250			
D-5	188	365	450		785	1.786.000	588.750			
D-4	224	589	450		1.011	2.128.000	758.250			
D-3	209	798	450		1.252	1.985.500	939.000			
D-2	213	1.011	450		1.489	2.023.500	1.116.750			
D-1	216	1.227	450	300	1.723	2.052.000	1.292.250	1.350.000		
Peak Day	1.793	3.020	450	300	680	17.033.500	510.000	1.350.000		
D+1	1.463	4.483	450	300		13.898.500	-	1.350.000	33	313.500
D+2	1.150	5.633	450	300		10.925.000		1.350.000	133	1.263.500
D+3	934	6.567	450	300		8.873.000		1.350.000	184	1.748.000
D+4	741	7.308	450	300	9	7.039.500	6.750	1.350.000		
D+5	596	7.904	450	300	163	5.662.000	122.250	1.350.000		-
D+6	499	8.403			414	4.740.500	310.500			-
	8.403		5.850	2.100		79.828.500	6.036.750	9.450.000	350	3.325.000

Obtained a profit of Rp. IDR. 61,016,750

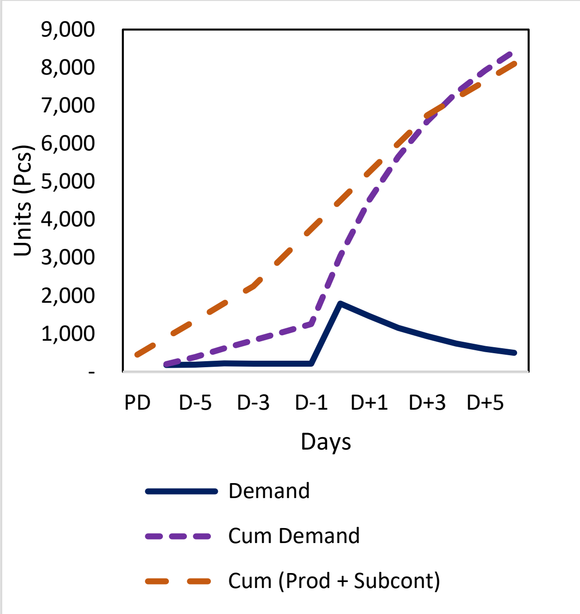

Figure 6. Illustration of the time over stock and stock out occurred in the adjusted mix strategy

4. Results and Discussion

Demand forecasting results on Harbolnas 12.12 experienced an increase of almost 900% from the average demand for the previous six days. Meanwhile, demand after Harbolnas decreased quite gently. This phenomenon is thought to have occurred due to a price discount (discount) which started during the National Harbolnas until the next few days. On this basis the company must begin to increase production capacity in order to be able to meet these needs but also not result in overstock.

By using the first strategy (strategy level) the company uses a maximum capacity of 450 pcs per day for two weeks. It can be seen that there was a fairly large buildup starting from D-6 to peak day, but there was a loss (lost sale) on the next day which resulted in not achieving maximum profit while the costs due to storage and lost sales were quite large. In this strategy, a net profit of IDR. 52,577,750. When there are excess goods and shortages can be seen more clearly in Figure 1.

In the second strategy (chase strategy) the production plan follows the existing demand level, starting from D-6 to D-2. In D-1 to D+6, the maximum capacity is 450 pcs per day. In this strategy, the company loses more sales than stock. The net profit achieved is smaller than the first strategy, which is Rp. 42,831,500.

The third strategy (Mix Strategy). To increase capacity, apart from using the maximum capacity, a two-week subcontract was also tried. This strategy causes a lot of overstock even though there is no shortage. The net profit achieved is IDR. 45,617,250.

The last strategy (adjusted mix strategy) the author makes adjustments by modifying the calculation, namely determining the number of days for the sub-contract and determining when the sub-contract should be started. Based on the calculation with the developed formula, it is found that the subcontract must be carried out for 7 days, starting from D-1 to D+5 with an average subcontract size of 300 per day. With this strategy there is a reduction in costs, both storage costs and lost sales costs. The net profit obtained experienced a significant increase in the amount of IDR. 61,016,750.

5. Conclusion

By trying to implement four strategies to anticipate peak demand at Harbolnas on 12 December 2024, there are several conclusions that can be drawn.

1. From the four proposed strategies, a better strategy was obtained, namely a mix strategy that was adjusted to earn a net profit of over 61 million in two weeks.
2. The four strategies both provide feasible solutions and can be applied as options, although the determination of the production plan still involves an intuitive aspect.

3. From the four strategies applied, it cannot be concluded that one strategy is better than another, because the four strategies are not optimization approaches in general. This is just a heuristic approach.

Acknowledgment

This article was taken from research with students majoring in Industrial Engineering at Universitas Jenderal Achmad Yani, Indonesia regarding production strategies to anticipate peak demand on the national online shopping day (Harbolnas). In the process of making this article, the author collaborated with several lecturers who were considered to understand this problem quite well.

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