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Distribution Design of Bottled Mineral Water 'Airku' with Distribution Requirement Planning Method (DRP) (Case Study at PDAM Tirta Binangun Kulon Progo)

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Abstract

PDAM Tirta Binangun Kulon Progo is a regional manufacturing company that produce gallon, cup and bottle packing mineral drinking water branded AirKu. The company use multi-echelon distribution network for the distribution system. Common problem that encountered by the company is insufficient or exceeded amount of product as a result of fluctuating demand from Agent, furthermore the Agent often find it hard to estimate the exact time for product to arrive. PDAM Tirta Binangun need a reliable model of planning and inventory system, and the method that can be used on their multi-echelon network distribution system is Distribution Requirement Planning (DRP). Distribution Requirement Planning is used to determine distribution activity that depend upon safety stock, lead time, inventory cost, order cost, and demand's forecast. The model is designed based on lot size that have the optimal cost to determine the gross requirement total, project on hand, net requirement, planned order receipt, planed order release and distribution cost. According to company's document, interview, and calculation the proper lot is Wagner Within Algorithm, distribution cost paid by Agent Aneka Usaha is Rp 1.768.076 for AirKu cup, Rp 781.388 for bottle AirKu, and Rp 174.275 for AirKu gallon. Distribution cost paid by Agent Post Office is Rp 881.630 for AirKu cup, Rp 300.613 for bottle AirKu, and Rp 228.375 for AirKu gallon. Distribution cost paid by Agent Umar is Rp 1.766. for AirKu cup, Rp 579.325 for bottle AirKu, and Rp 454.256 for AirKu gallon. Distribution cost paid by Agent Joko Sendang is Rp 1.903.623 for AirKu cup, Rp 656.506 for bottle AirKu, and Rp 189.450 for AirKu gallon.

Keywords : Distribution, Distribution Requirement Planning, Lot Size, Inventory

INTRODUCTION

Mineral drinking water industry in Indonesia is full of innovation and market competition. Market competition to draw costumer is not only on national level but also on smaller level such as a region. To gain competitive advantage, the company need a proper strategy to fullfil costumer satisfaction such as on time distribution corresponding to the demand and cost efficiency. Distribution is a necessary process for a company to assure that the product could reach the costumer. Regular problem on the distribution process is excess product on inventory, product misplace, bad costumer service, and losing sales as cause of insufficient supply (Indrajit dan Djokopranoto, 2004). Policy on planning and control of inventory have significant impact on product availability, on time delivery, and proper quantity of distribution corresponding to the demand. PDAM Tirta Binangun Kulon Progo is a regional company that manufacture gallon, cup and bottle packing mineral drinking water branded AirKu. AirKu is produced due to diversification of Perusahaan Daerah Air Minum (PDAM) Tirta Binangun. AirKU introduced on 2013 in 240ml cup package, packed into boxes consist of 48 cups. On 2015 the company start to manufacture 19 liters gallon package and 600ml bottle package packed into box consist of 16 bottles (PDAM Tirta Binangun Kulon Progo, 2018). AirKU is using multi-echelon network distribution system throughout official Agent that patnert with PDAM. Some of the Agent is Aneka Usaha, Agent Post Office, Agent Umar, Agent Joko Sendang. The distribution flow is describe as follow:

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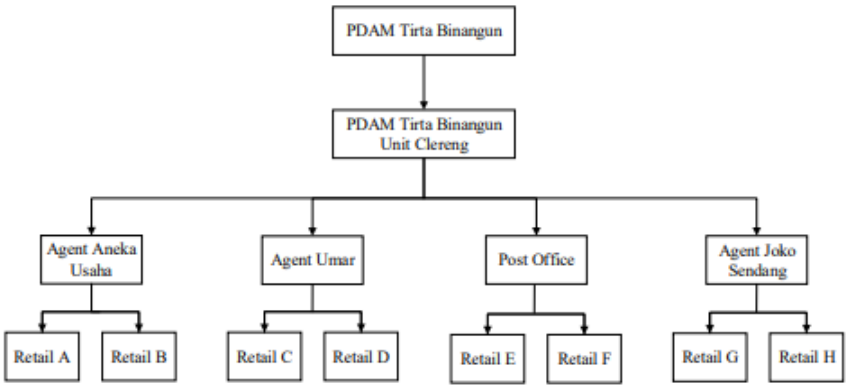

Figure 1. Product Distribution Flow

Currently PDAM Tirta Binangun is capable of manufacture 500 boxes AirKu 240 ml, 40 boxes of 600 ml AirKu, and 50 gallons 19 liters AirKu that distributed to the Agents on Kulon Progo daily. Distribution of the product is delivered by company's vehicle which is Daihatsu Grand Max. The car is capable of carrying 125 boxes AirKu 240 ml, or 80 boxes of 600 ml AirKu, or 40 19 liters gallons AirKu. Based on 2017 production and sales record, it can be concluded that the manufactured product is not as same as the costumer's demand, the record is described as follow:

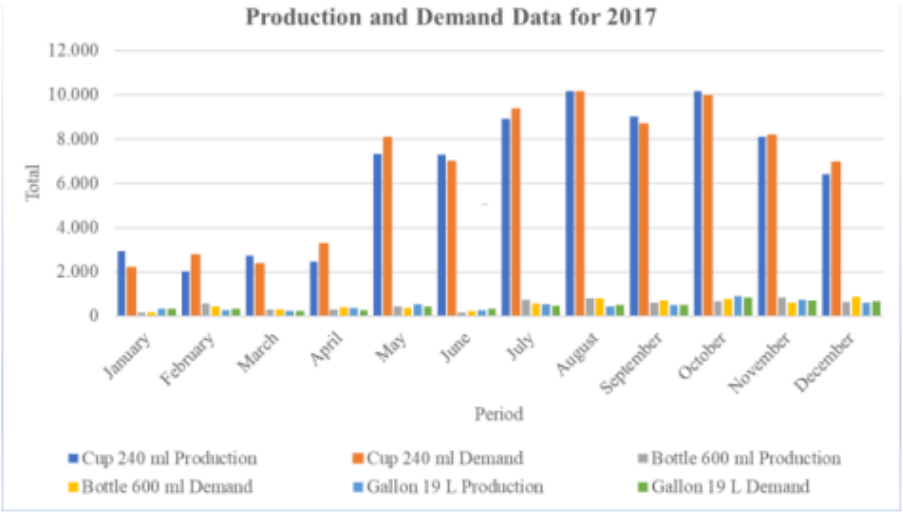

Figure 2. Production and Demand Diagram

The unbalanced number of the production and demand causing the Agent unable to fullfil the demand or when there is leftover product, it also cost the Agent inventory cost. This problems indicates that PDAM Tirta Binangun need a reliable model of inventory planning and distribution. With such problem at hand, a reliable model of inventory planning and distribution could guarantee a controlled and calculated distribution. A model that can be used in multi-echelon network distribution is Distribution Requirement Planning (DRP). According to Bowersox, et al. (2013) Distribution requirement planning is a system that can forecast demand on distribution center, combine historical demand, and as an input to production and material system. By applying DRP method, the distribution system is expected to be well planned, the company could make an efficient distribution activity to optimize the success to fullfil customer's demand, increasing in sales performance to fullfil the demand on time on exact amount of product.

The DRP method has been used in several studies with various research objects that have a multi-echelon distribution system, such as that conducted by Garside (2001). Based on this research, it is known that with the DRP method PT Coca Cola can optimize the availability of its products both in the warehouse and outlets, this is evidenced by the amount of inventory that has always accumulated in large quantities in each outlet and warehouse as a result of product delivery policies can be reduced only by the amount of safety stock which functions as a safety stock in the event of fluctuating demand. With the DRP method, PT Coca Cola can find out when to send each product from the central warehouse to each warehouse and from the warehouse to each outlet exactly. Wicaksono (2008) in a journal entitled "Proposed application of Distribution resource planning (DRP) to Support Supply chain Strategy", researchers use the Distribution resource planning method with the EOQ lot size determination method, research shows the application of

DRP can help forecast product demand for the coming period using the economic order quantity model so that it is known when the reorder point is, and how much stock must be provided as safety stock.

According to Schroeder, et al. (2011) in his book Operations Management, Safety stock is an additional inventory held to protect or maintain the possibility of material shortages (stock out). Stock out can be caused by the use of raw materials that are greater than the original estimate or delays in raw materials ordered. With the safety stock will reduce stock out costs for the company. However, it will cause additional carrying costs equal to the multiplication of the percentage of carrying costs to the price or value of safety stock. For this reason, determining the optimum safety stock is very necessary.

According to Sofyan (2013), the calculation of safety stock can be calculated by taking into account deviations that have occurred between the amount of demand and the grace period (lead time). There are 4 methods of calculating safety stock, namely:

1. The number of requests and the grace period are constant.
2. The amount of demand is variable, while the grace period is constant.
3. The amount of demand is constant, while the grace period is variable.
4. Both the amount of demand and the grace period are variable.

Based on these reasons, the chosen topic is "Distribution Planning on Packed Mineral Water 'AirKu' by Distribution Requirement Planning (DRP) method".

METHODS

On this research, the primary data is product distribution mechanism and lead time data, and secondary data is product's bill of distribution, product demand data, early stock data, Agent data, and distribution operational vehicle. The demand data then used to forecast using moving average, weight moving average, and winter's method then the best result is selected based on these three methods. The forecast result is then used as gross requirement. Based on the gross requirement, the safety stock can be calculated. To determine the amount of product to be distributed, lot sizing is calculated using fixed period requirement, lot for lot, period order quantity, part period balancing, least unit cost, silver meal, and wagner within algorithm to determine the optimum lot size. Then net requirement and projected on hand for every period is calculated.

The method used for problem solving in this research is the distribution requirement planning method, the logic of the DRP method consists of method logic consists of several stages, namely:

a. Determining Gross Requirements
   Gross requirements show the amount of demand for each product each period. Gross requirements are obtained from the results of demand forecasting, the forecasting methods used are Moving Average, Weight Moving Average, and Winter's. Gross requirements are obtained from the results of demand forecasting with the best forecasting method. best forecasting method.
b. Determining Net Requirements
   Net requirements show the quantity of product required distributor company to place an order to the factory in order to be able to meet demand in that period. The following is the calculation formula net requirements:

   Net requirements = (Gross requirements + Safety stock) - (Schedule receipt + Projected on hand for the previous period)

   The recorded net requirement value is a positive value.
c. Determining Lot Size or Lot size
   Calculation of the size of the ordering capacity (Lot sizing) using the Lot For Lot (LFL) method, Least Unit Cost (LUC), Period Order Quantity (POQ), Part period Balancing (PPB), Silver Meal (SM), Fixed Period Requirement (FPR), Wagner Within Algorithm (FPR), and Wagner Within Algorithm (FPR). Requirement (FPR), Wagner Within Algorithm (AWW), after which the best order capacity size is selected. the best order capacity size.
d. Determining Planned Order Receipt and Planned Order Release receipt and Planned order release

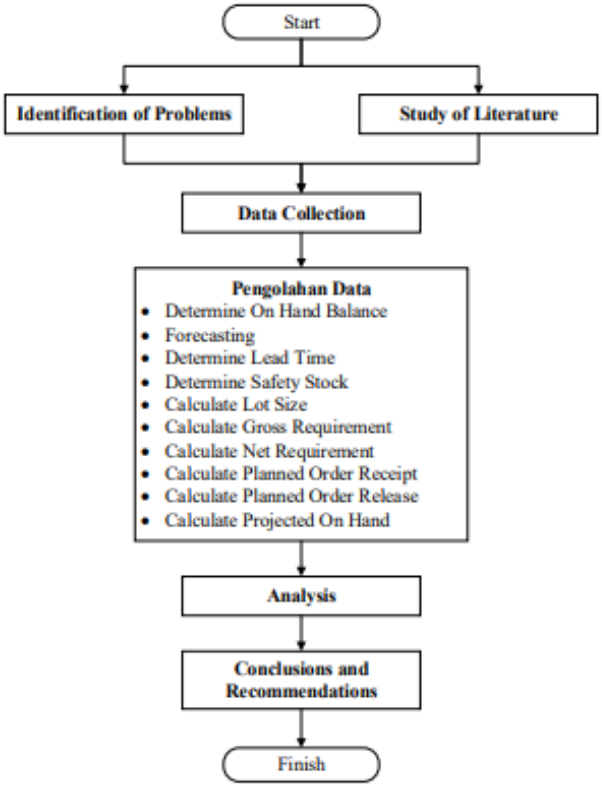

Figure 3. Research Flow Diagram

RESULT AND DISCUSSION

To distribute Packed Mineral Water 'AirKu', PDAM Tirta Binangun is partnering with few Agents on Kulon Progo region. The distribution network that is used on this research is only distribution from PDAM Tirta Binangun to Agent Perumda Aneka Usaha, CV Joko Sendang, Toko Umar, Post Office, Toko Mika, and Koperasi PDAM.

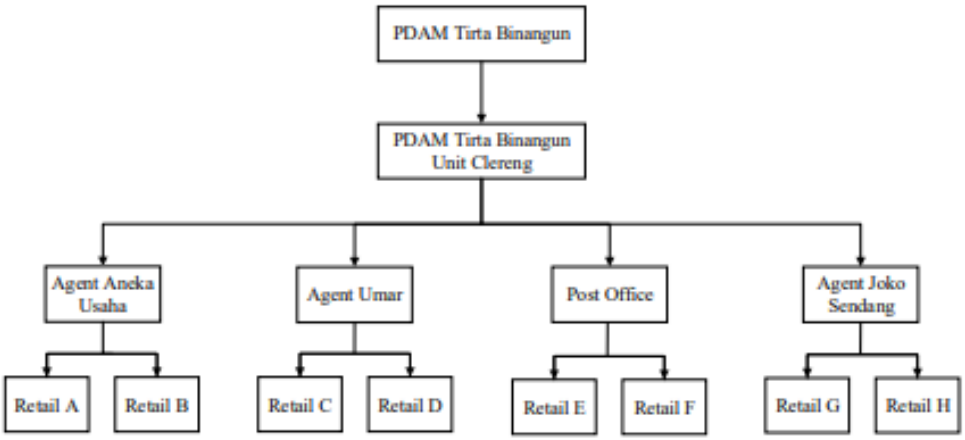

Figure 4. Distribution Diagram

The demand record used on this research is demand from last 24 months started from March 2016 to Februari 2018 recorded by PDAM Tirta Binangun. The researched product is Packed Mineral Water 240 milliliters on cup package, 600 milliliters on bottled package, and 19 liters on gallon package. The cup and bottle package is distributed on boxes consist of 40 240 mililiter cup and 16 600 milliliter bottle. Demand record for each product from the Agents is as following:

Table 1. Demand Data of Airku

Period	Aneka Usaha			Umar			Post Office			Joko Sendang		
	Cup	Bottle	Gallon	Cup	Bottle	Gallon	Cup	Bottle	Gallon	Cup	Bottle	Gallon
Mar-16	4530	50	52	600	25	64	54	15	17	761	32	20
Apr-16	4150	60	34	750	37	53	210	10	11	653	44	18
May-16	3480	60	41	750	67	70	106	31	10	550	36	8
Jun-16	9000	75	45	1500	44	61	85	20	14	500	30	6
Jul-16	5245	40	147	350	55	63	77	34	17	549	38	12
Aug-16	9000	105	33	1100	50	51	238	12	13	672	41	21
Sep-16	7035	100	60	1100	15	68	102	39	10	540	48	16
Oct-16	8025	50	40	750	25	56	149	15	18	526	47	24
Nov-16	8919	110	103	800	33	55	60	17	10	595	41	22
Dec-16	5870	431	64	1200	48	68	142	11	16	654	33	7
Jan-17	100	45	85	600	30	78	152	15	16	757	35	46
Feb-17	1110	100	55	900	68	80	100	32	13	327	96	18
Mar-17	500	160	24	500	35	112	247	16	10	628	72	22
Apr-17	1595	70	40	1300	81	10	50	19	27	485	176	14
May-17	2605	70	20	1350	30	95	50	27	29	1421	78	20
Jun-17	1700	60	51	1100	40	73	150	20	20	1495	41	25
Jul-17	3065	75	10	1700	53	51	606	25	14	1270	50	11
Aug-17	2675	240	17	1300	30	86	500	20	23	2705	210	6
Sep-17	2180	140	10	1670	50	121	250	10	17	2100	40	4
Oct-17	2545	123	30	1628	40	104	450	32	20	2250	74	14
Nov-17	1798	50	11	1475	56	111	300	15	18	1700	35	8
Dec-17	1400	110	8	1250	93	78	300	10	21	1315	34	5
Jan-18	2250	90	32	1580	60	146	450	10	19	2000	44	10
Feb-18	1000	10	15	880	60	116	260	25	25	1102	71	5

Lead time is the waiting time started from ordering to retrieving point on the Agent, for every Agent there is different lead time, the lead time data for each Agent is as following:

Table 2. Lead Time Data

Agentt	Lead Time (Day)
Aneka Usaha	1
Post Office	3
Umar	1
Joko Sendang	1

The amount of started stock for each period on each distribution level is depending on how much fluctuation on the demand and smoothness the distribution. The early stock of each period is based on latest stock of last period.

Table 3. Initial Product Inventory

Agentt	Jenis Produk		
	Cup (dus)	Bottle (dus)	Gallon
Aneka Usaha	0	0	0
Post Office	0	0	0
Umar	0	0	0
Joko Sendang	0	0	0

The one of the cost accounted for total inventory cost calculation is product cost. Product cost is the price Agent paid for the price, this cost is the price for each box delivered by PDAM Tirta Binangun.

Table 4. Product Prices

Product	Price/ Dus
Cup (dus)	Rp15.000
Bottle (dus)	Rp30.000
Gallon	Rp10.000

Ordering cost is the cost paid by Agents for each delivery, is as following:

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Table 5. Set Up Cost

Cost Breakdown	Aneka Usaha	Post Office	Umar	Joko Sendang
Administration	Rp5.000	Rp5.000	Rp5.000	Rp5.000
Employee Salary	Rp43.750	Rp43.750	Rp43.750	Rp43.750
Transportation	Rp25.000	Rp25.000	Rp25.000	Rp25.000
Total	Rp73.750	Rp73.750	Rp73.750	Rp73.750

Inventory cost charged for 1 box is equal to 1% of the monthly selling price of the product or 0,25% of the weekly selling price of the product.

Table 6. Holding Cost

Product	Price	Cost/ Dus/ Week (0,25%)
Cup	Rp15.000	Rp38
Bottle	Rp30.000	Rp75
Gallon	Rp10.000	Rp25

a. Forecasting

The forecast is done using Moving average, Weight moving average, and Winter's method. The forecast results from the three methods shows the best result that have smaller MAD, MSE, and MAPE value, as following:

Table 7. The Best Forecasting Method

Aneka Usaha	*Winter's Multiplicative*			*Winter's Additive*		
	MAPE	MAD	MSD	MAPE	MAD	MSD
Cup	108	837	1030036	-	-	-
Bottle	67,35	36,89	2547,77	-	-	-
Gallon	64,94	17,42	538,87	-	-	-
Post Office	*Winter's Multiplicative*			*Winter's Additive*		
	MAPE	MAD	MSD	MAPE	MAD	MSD
Cup	43,9	71,5	10632,1	-	-	-
Bottle	-	-	-	23,64	4,12	36,98
Gallon	19,37	3,28	18,97	-	-	-
Umar	*Winter's Multiplicative*			*Winter's Additive*		
	MAPE	MAD	MSD	MAPE	MAD	MSD
Cup	24,7	237,5	84752,9	-	-	-
Bottle	24,99	9,93	197,88	-	-	-
Gallon	26,06	13,92	266,7	-	-	-
Joko Sendang	*Winter's Multiplicative*			*Winter's Additive*		
	MAPE	MAD	MSD	MAPE	MAD	MSD
Cup	19,6	168,2	53886,1	-	-	-
Bottle	27,2	14,89	449,11	-	-	-
Gallon	43,01	5,17	42,24	-	-	-

Based on the method that have the smallest value of error on MAD, MAPE, and MSE, the demands for the next 12 months for each Agents could be determined as follows:

Table 8. Forecast Result

Period	Aneka Usaha			Post Office			Umar			Joko Sendang		
	Cup	Bottle	Gallon	Cup	Bottle	Gallon	Cup	Bottle	Gallon	Cup	Bottle	Gallon
Mar-18	1618	65	14	220	12	17	673	35	110	1208	58	11
Apr-18	1763	47	14	201	10	24	1241	69	41	978	126	9
May-18	1767	55	11	118	25	25	1273	58	105	1617	68	9
Jun-18	2799	64	17	172	15	22	1603	50	86	1609	44	12
Jul-18	2040	61	27	485	25	21	1233	64	74	1454	56	9
Aug-18	2569	202	9	532	11	24	1474	48	89	2632	162	12
Sep-18	1824	154	12	252	19	18	1697	38	123	2029	59	10
Oct-18	1854	120	12	424	18	26	1452	39	105	2100	83	20
Nov-18	1621	120	18	252	10	19	1395	53	109	1724	54	17
Dec-18	933	437	11	312	4	26	1519	85	98	1469	49	7
Jan-19	267	116	18	420	6	25	1335	54	150	2017	59	36
Feb-19	175	101	11	250	22	27	1109	78	132	1026	127	16

b. Safety Stock

The calculation for the safety stock if the demands for each Agent is varies. Lead time for the product to ordered to retrieved, with service level of 95%.

Table 9. Safety Stock

Safety Stock	Cup	Bottle	Gallon
Aneka Usaha	60	8	0
Post Office	17	1	0
Umar	20	1	2
Joko Sendang	36	3	1

c. Master Distribution Schedule

On this research, the distribution is done weekly with assumption that a month is consist of 4 weeks, so the result for monthly period would be divided by 4, as shows on the table below:

Table 10. Master Distribution Schedule

Period (Week)	Aneka Usaha			Post Office			Umar			Joko Sendang		
	Cup	Bottle	Gallon	Cup	Bottle	Gallon	Cup	Bottle	Gallon	Cup	Bottle	Gallon
Week 1	405	16	4	55	3	4	168	9	28	302	15	3
Week 2	405	16	4	55	3	4	168	9	28	302	15	3
Week 3	405	16	4	55	3	4	168	9	28	302	15	3
Week 4	405	16	4	55	3	4	168	9	28	302	15	3
Week 5	441	12	4	50	3	6	310	17	10	245	32	2
Week 6	441	12	4	50	3	6	310	17	10	245	32	2
Week 7	441	12	4	50	3	6	310	17	10	245	32	2
Week 8	441	12	4	50	3	6	310	17	10	245	32	2
Week 9	442	14	3	30	6	6	318	15	26	404	17	2
Week 10	442	14	3	30	6	6	318	15	26	404	17	2
Week 11	442	14	3	30	6	6	318	15	26	404	17	2
Week 12	442	14	3	30	6	6	318	15	26	404	17	2
Week 13	700	16	4	43	4	6	401	13	22	402	11	3
Week 14	700	16	4	43	4	6	401	13	22	402	11	3
Week 15	700	16	4	43	4	6	401	13	22	402	11	3
Week 16	700	16	4	43	4	6	401	13	22	402	11	3
Week 17	510	15	7	121	6	5	308	16	19	364	14	2
Week 18	510	15	7	121	6	5	308	16	19	364	14	2
Week 19	510	15	7	121	6	5	308	16	19	364	14	2
Week 20	510	15	7	121	6	5	308	16	19	364	14	2
Week 21	642	51	2	133	3	6	369	12	22	658	41	3
Week 22	642	51	2	133	3	6	369	12	22	658	41	3
Week 23	642	51	2	133	3	6	369	12	22	658	41	3
Week 24	642	51	2	133	3	6	369	12	22	658	41	3
Week 25	456	39	3	63	5	5	424	10	31	507	15	3
Week 26	456	39	3	63	5	5	424	10	31	507	15	3
Week 27	456	39	3	63	5	5	424	10	31	507	15	3
Week 28	456	39	3	63	5	5	424	10	31	507	15	3
Week 29	464	30	3	106	5	7	363	10	26	525	21	5
Week 30	464	30	3	106	5	7	363	10	26	525	21	5
Week 31	464	30	3	106	5	7	363	10	26	525	21	5
Week 32	464	30	3	106	5	7	363	10	26	525	21	5
Week 33	405	30	5	63	3	5	349	13	27	431	14	4
Week 34	405	30	5	63	3	5	349	13	27	431	14	4
Week 35	405	30	5	63	3	5	349	13	27	431	14	4
Week 36	405	30	5	63	3	5	349	13	27	431	14	4
Week 37	233	109	3	78	1	7	380	21	25	367	12	2
Week 38	233	109	3	78	1	7	380	21	25	367	12	2
Week 39	233	109	3	78	1	7	380	21	25	367	12	2
Week 40	233	109	3	78	1	7	380	21	25	367	12	2
Week 41	67	29	5	105	2	6	334	14	38	504	15	9
Week 42	67	29	5	105	2	6	334	14	38	504	15	9
Week 43	67	29	5	105	2	6	334	14	38	504	15	9
Week 44	67	29	5	105	2	6	334	14	38	504	15	9
Week 45	44	25	3	63	6	7	277	20	33	257	32	4
Week 46	44	25	3	63	6	7	277	20	33	257	32	4
Week 47	44	25	3	63	6	7	277	20	33	257	32	4
Week 48	44	25	3	63	6	7	277	20	33	257	32	4

d. Lot Sizing

Lot sizing calculation is done using Period Order Quantity (POQ), Fixed Period Requirement (FPR), Lot For Lot (LFL), Wagner Within Algorithm, Silver Meal (SM), Part period Balancing (PPB), and Least Unit Cost (LUC) method, and the lot sizing method that have the smallest cost is Wagner Within Algorithm.

Table 11 The Result of The Lot Sizing Calculation

Agent	Types of Products	POQ	FPR	LFL	PPB	SM	AWW	LUC
Aneka Usaha	Cup	Rp1.900.841	Rp2.086.902	Rp3.646.115	Rp1.942.159	Rp1.930.179	Rp1.768.076	Rp3.437.701
	Bottle	Rp907.275	Rp1.160.825	Rp3.568.800	Rp869.344	Rp845.175	Rp781.388	Rp2.380.225
	Gallon	Rp219.025	Rp400.475	Rp3.540.000	Rp222.913	Rp219.025	Rp174.275	Rp1.017.775
Post Office	Cup	Rp912.182	Rp1.210.318	Rp3.571.008	Rp922.820	Rp933.175	Rp881.630	Rp3.078.299
	Bottle	Rp356.569	Rp570.825	Rp3.568.800	Rp368.419	Rp332.363	Rp300.613	Rp2.210.038
	Gallon	Rp236.875	Rp547.975	Rp3.540.000	Rp238.369	Rp228.375	Rp228.375	Rp1.323.788
Umar	Cup	Rp1.785.863	Rp1.941.780	Rp3.576.480	Rp1.839.475	Rp1.839.817	Rp1.766.966	Rp3.316.629
	Bottle	Rp580.488	Rp1.013.325	Rp3.568.800	Rp582.850	Rp580.000	Rp579.325	Rp5.023.938
	Gallon	Rp505.475	Rp916.725	Rp3.540.000	Rp459.138	Rp519.669	Rp454.256	Rp2.497.475
Joko Sendang	Cup	Rp1.941.292	Rp2.112.495	Rp3.605.664	Rp2.021.742	Rp1.981.167	Rp1.903.623	Rp3.387.606
	Bottle	Rp664.588	Rp1.087.075	Rp3.568.800	Rp686.375	Rp665.881	Rp656.506	Rp3.082.250
	Gallon	Rp219.125	Rp400.475	Rp3.540.000	Rp219.125	Rp211.200	Rp189.450	Rp466.250
Total Biaya		Rp10.229.596	Rp13.449.195	Rp42.834.467	Rp10.372.726	Rp10.286.025	Rp9.684.481	Rp31.221.972

e. Preparation of Distribution Requirement Planning Table

Table 12. AWW Aneka Usaha Cup

Period	1	.	.	39	40	41	42	43	44	45	46	47	48	Total
Gross Requirement	405			233	233	67	67	67	67	44	44	44	44	19230
Schedule Receipts														0
Project On Hand	809			675	442	375	309	242	175	131	88	44	44	19357
Net Requirement	465			293	0	0	0	0	0	0	0	0	0	8603
Planned Order Receipts	1214			909										19230
Planned Order Release	1214			909	0	0	0	0	0	0	0	0	0	19230
Set Up Cost	73750			71750	-	-								10325000
Holding Cost	30742			25660	16796	14260	11723	9187	6650	4988	3325	1663		755576
														1768076

Table 13. AWW Aneka Usaha Bottle

Period	1	.	.	39	40	41	42	43	44	45	46	47	48	Total
Gross Requirement	16			109	109	29	29	29	29	25	25	25	25	1542
Schedule Receipts														0
Project On Hand	137			0	217	188	159	130	101	76	51	25	0	4519
Net Requirement	24			8	117	0	0	0	0	0	0	0	8	434
Planned Order Receipts	153			326	326	326	326	326	326	326	326	326	326	1542
Planned Order Release	153			0	326	0	0	0	0	0	0	0	0	1542
Set Up Cost	71354				73750									442500
Holding Cost	10275				16275	14100	11925	9750	7575	5681	3788	1894		338888
														781388

Table 14. AWW Aneka Usaha Gallon

Period	1	.	.	39	40	41	42	43	44	45	46	47	48	Total
Gross Requirement	4			3	3	5	5	5	5	3	3	3	3	174
Schedule Receipts														0
Project On Hand	171			32	29	25	20	16	11	8	6	3	0	4021
Net Requirement	4			0	0	0	0	0	0	0	0	0		4
Planned Order Receipts	174													124
Planned Order Release	174			0	0	0	0	0	0	0	0	0	0	124
Set Up Cost	73750													73754
Holding Cost	4263			794	725	613	500	388	275	206	128	69		100525
														174275

Table 15. AWW Post Office Cup

Period	1	.	.	39	40	41	42	43	44	45	46	47	48	Total
Gross Requirement	55			78	78	105	105	105	105	63	63	63	63	3638
Schedule Receipts														0
Project On Hand	316			183	105	0	460	355	250	188	125	63	0	9615
Net Requirement	72			0	0	17	122	0	0	0	0	0	17	872
Planned Order Receipts	371						565	565						3618
Planned Order Release	371			0	0	0	565	0	0	0	0	0	0	3618

Period	1	.	.	39	40	41	42	43	44	45	46	47	48	Total
Set Up Cost	73750						73750							516254
Holding Cost	11999			6950	3990		17450	13490	9500	7125	4750	2375		365380
														881630

Table 16. AWW Post Office Bottle

Period	1			39	40	41	42	43	44	45	46	47	48	Total
Gross Requirement	3			1	1	2	2	2	2	6	6	6	6	177
Schedule Receipts														0
Project On Hand	95			30	28	27	25	24	22	17	11	6	6	2042
Net Requirement	4			0	0	0	0	0	0	0	0	0	1	12
Planned Order Receipts														177
Planned Order Release	98			0	0	0	0	0	0	0	0	0	0	177
Set Up Cost	23750			Rp. -	Rp. -	Rp. -	Rp. -	Rp. -	Rp. -	Rp. -	Rp. -	Rp. -	Rp. -	147500
Holding Cost	5123			2.250	2100	1955	1875	1763	1650	1238	825	413	Rp.-	153113
														300.613

Table 17. AWW Post Office Gallon

Period	1				40	41	42	43	44	45	46	47	48	Total
Gross Requirement	4			7	7	7	6	6	6	7	7	3	7	4
Schedule Receipts														
Project On Hand	147			59	52	46	40	33	27	20	14	3		147
Net Requirement	4			0	0	0								4
Planned Order Receipts	151													151
Planned Order Release	151			0	0	0								151
Set Up Cost	Rp23.750			Rp.-	Rp.-	Rp.-								Rp23.750
Holding Cost	Rp. 3119			1461	1300	Rp1.144	988	831	675	506	328	169		Rp. 3119
														228375

Table 18. AWW Umar Cup

Period	1			39	40	41	42	43	44	45	46	47	48	Total
Gross Requirement	168			380	380	334	334	334	334	277	271	277	277	168
Schedule Receipts														
Project On Hand	505			0	668	334	0	611	227	0	555	277	0	505
Net Requirement	188			20	400	0	20	354	0	20	297	0	20	188
Planned Order Receipts	673				1047	1047		945			832			673
Planned Order Release	673			0	1047	0		945	0		832	0	0	673
Set Up Cost	73750				73290			72750		0	23750			73750
Holding Cost	19181			Rp0	25365	12682		23210	10536		21071	19.536		19181
														1.766.966

Table 19. AWW Umar Bottle

Period	1	.	.	39	40	41	42	43	44	45	46	47	48	Total
Gross Requirement	9			21	21	14	14	14	14	20	20	20	20	671
Schedule Receipts														0
Project On Hand	166			153	132	119	105	92	78	59	39	20	0	2791
Net Requirement	10			0	0	0	0	0					1	60
Planned Order Receipts	175													671
Planned Order Release	175			0	0	0	0							671
Set Up Cost	73750													295000
Holding Cost	12431			Rp11.494	9900	5555	7875	6563	5850	4388	2925	Rp1.463		284325
														579.325

Table 20.AWW Umar Gallon

Period	1	.	.	39	40	41	42	43	44	45	46	47	48	Total
Gross Requirement	28			25	25	38	38	38	38	33	33	33	33	1222
Schedule Receipts														0
Project On Hand	389			307	282	245	207	170	122	99	66	33		9120
Net Requirement	30			0	0			0					2	89
Planned Order Receipts	416													1222
Planned Order Release	416			0	0									1222
Set Up Cost	73750													221250
Holding Cost	9713			Rp7.663	7050	6111	5175	4218	3300	2475	1650	Rp825		231006
														Rp454.256

Table 21. AWW joko Sendang Bottle

Period	1	.	.	39	40	41	42	43	44	45	46	47	48	Total
Gross Requirement	15			12	12	15	15	15	15	32	32	32	32	945
Schedule Receipts														0
Project On Hand	138			27	15		157	142	127	95	64	32	0	3817
Net Requirement	18			0		3	18						1	152
Planned Order Receipts	153						171							945
Planned Order Release	153						171							945
Set Up Cost	73.750						73750							268750
Holding Cost	19350			2025	1106		11730	10631	9525	7144	4763	2281		287756
														656566

Table 22.AWW joko Sendang Gallon

Period	1	…	39	40	41	42	43	44	45	46	47	48	Total
Gross Requirement	9		2	2	9	9	9	9	4	4	4	4	168
Schedule Receipts													0
Project On Hand	166		54	52	42	34	25	16	12	8	4	0	4628
Net Requirement	10		0	0	0	0	0	0	0	0	0	1	5
Planned Order Receipts	175												
Planned Order Release	175		0	0	0	0	0	0		0		0	168
Set Up Cost	73.756												73750
Holding Cost	12431		1244	1300	Rp1.073	850	625	400	300	200	100		1157500
													189450

CONCLUSION

According to the data, calculation, and the analysis can be concluded that the best forecasting method to Agent Aneka Usaha, Agent Post Office, Agent Umar, and Agent Joko Sendang for product AirKu cup, bottle, and gallon packed is Winter multiplicative, except for Agent Post Office for AirKu bottle is using Winter Additive. The amount of safety stock for Agent Aneka Usaha is AirKu cup 60 boxes, bottled AirKu 8 boxes, for Agent Agent Post Office is 17 boxes AirKu cup, 1 box bottled AirKu, for Agent Umar 20 boxes AirKu cup, 1 box bottled AirKu, and 2 gallons gollon AirKu, and for Agent Joko Sendang 36 boxes of AirKu cup, 3 boxes of bottled Airku, and 1 gallons AirKu gallon. The distribution planning calculated under assumtion that a month is consist of 4 weeks, so that the monthly demands is divided by 4. The delivery is adjusted according to the most reliable lot sizing that produce the optimal amount of cost, which is using the Wagner Within Algorithm resulting the total cost of Rp 9.684.481.

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