

## MAXIMUM PROFIT CALCULATION BASED ON THE QUANTITY OF DEMAND VEGATABLES WITH THE SINGLE ORDER QUANTITY METHOD

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### ABSTRACT

*Inventory is one of the most important financial aspects in an enterprise, because it directly impacts revenue. This research discusses uncertainty and perishable demand of vegetable products in AAA Company. AAA supplied organic and hydroponic vegetables to consumers such as supermarkets and restaurants. This research uses the Single Order Quantity method. The items produced that are ordered at a particular time can only be consumed by the demand during that period. The objective is to calculate the maximum benefit obtained by the company based on the quantity reserved. Vegetables with the highest demand are red cherry tomatoes, TW tomatoes, Recento tomatoes, green spinach and edamame. Profit obtained from red cherry tomatoes was IDR 2,925,000 from 6,150 packs, for green spinach IDR 346,875 from 26,850 packs, for edamame, IDR 262,618 from 650 packs, for TW tomatoes IDR 3,333,333 from 3,650 packs for Recento tomatoes was IDR 1,462,500 from 3,000 packs.*

*Key words: quantity reservation, uncertain demand, perishable goods, single order quantity*

## 1. INTRODUCTION

### 1.1. Research Background

Inventory is such a crucial element in any company, because this will directly impact on a company's income. Hence, this paper will discuss how a company's profit is reflected by the quantity of products that they order. AAA Company distributes from supplier to consumer who demand the produce. Distribution is carried out according to the quantity demanded by the customers, which then is done though Single Order Quantity (SOQ).

### 1.2 Objective

The objective of this research is to: (1) Identify which fresh produce is perishable according to the level of demand. (2) To identify the quantity demanded to achieve the highest profit.

## 2. THEORETICAL BACKGROUND

### 2.1. Availability/In stock System

The method of controlling the available inventory is varied due to the wide range of

conditions/ environments. These wide range of conditions are caused by:

- a. Seasonal demand
- b. Demand that occurs due to the availability of stock of fresh produce or from repeat orders.
- c. Uncertainty of demand and waiting period.

### 2.2. Single Order Quantity

The Single Order Quantity model is related to planning and controlling inventory items which have the chance of being ordered once. Those items are produced or ordered within a certain period and can only be distributed within that certain period of time. At the end of that particular period, the demand for those items are small or none. If the company is unable to fulfil the demand, there is not another second opportunity for the company and the value of that particular item is diminished or gone. This kind of method is suitable for items that have fluctuating demands and have short life spans, such as newspapers, flowers, and perishable foods, etc.

Apart from the fact that SOQ is also suitable for items with non-continuous and ever changing demands with a short life span, especially for these two items:

### 2.2.1. Infrequent demand items

This kind of demand is for items with a continually changing model, components parts that are not easy to be faulty and spare parts for certain items intended for repair and maintenance.

### 2.2.2. Uncertain demands

This kind of demand is for items that have short intervals within a frequent demand. The items for this demand are items that are perishable and quickly expire. If the demand is greater than the anticipated one, hence the product shortage cannot be fulfilled in the next period (backorder) resulting in excess cost. Vice versa, if the demand is less than the quantity supplied, then there are three possibilities:

- a. Products are thrown out because they can no longer be used
- b. Products are sold at a cheaper price
- c. Products are kept for the next period

When demand keeps changing and lead time is identified, the problem of Single Order Inventory is on the quantity of demand. If quantity demanded is identified, but there is a distribution probabilistic demand, the issues can be solved. According to Kennardi (2003), for determining the quantity of demand Q, if A is the actual sales, so  $A = \min \{Q, D\}$ . During demand D is random variable, A is variable demand too, so profit for problem  $S > 0$  is:

$$Z(Q, D) = (R + H + S)A - SD - (C + H)Q \quad (1)$$

where:

- C: cost of purchasing
- R: sales revenue
- D: Demand
- H: excess costs/unit because of the remaining quantity
- S: The cost of deficiency/unit because unable to meet demand

Below are some of the formulae used in Single Order Quantity calculations with probabilistic demand distribution normally distributed (Tersine, 1994) :

#### 1. Probability the shortage (under stock)

$$P(\text{demand} > Q^*) = \frac{cu}{(cu+co)} \quad (2)$$

where :

- $Q^*$  : Reserving optimal quantity
- $C_u$  : Cost if the order < the demand
- $C_o$  : Cost if the order quantity > the demand

#### 2. Probability not the shortage (over stock)

$$P(\text{demand} < Q^*) = 1 - \frac{cu}{(cu+co)} \quad (3)$$

This approach in single order quantity can be divided into two that is under stock and over stock, if the output expected is profit so the formula that can be used is as follows:

$$F(Q_i, M_j) = Q_i \cdot j - (M_j - Q_i)A \text{ for } Q_i \leq M_j \text{ (Under Stock Condition)} \quad (4)$$

$$F(Q_i, M_j) = M_i \cdot j - (Q_i - M_j)L \text{ for } Q_i > M_j \text{ (Over Stock Condition)} \quad (5)$$

$$\text{Expected Value } E(QN) = \sum (\text{matrix value } \times \text{probability}) \quad (6)$$

## 3. RESEARCH METHOD

Figure 1 illustrates a flowchart of research which shows the thought process about the research conducted by AAA Company.

The first step of this research involves formulating the problems related to AAA Company. Furthermore, literature review as a reference is required to do research and preparation of appropriate reports in the form of books, articles, and journals relating to the research conducted. The writer can then collect the data and make calculations and conduct analyses for the demand of vegetables. Collection of data is data demand during a particular period or 12 months. The next step is to calculate the data, plot this data representing the demand from each vegetable. The research would use the Single Order Quantity method.

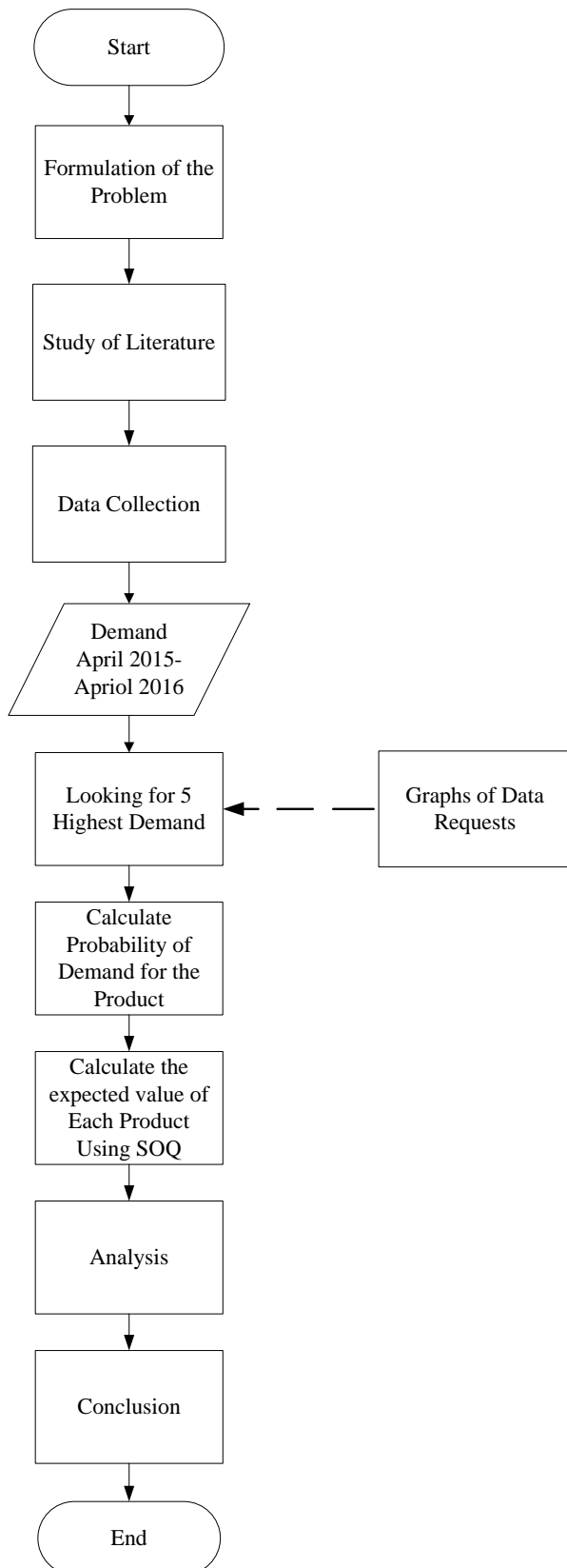


Figure 1. Research Method

## 4. RESULT AND DISCUSSION

### 4.1. Data Demand

Data demand of vegetable consumers in AAA Company, obtained by a history of data demand during 12 months from April 2015 to April 2016. This research will focus on 5 vegetables. The authors have plotted the data in a bar chart (Figure 2) using the data from Table 1.

### 4.2. Single Order Quantity

The next step is to make calculation using the Single Order Quantity method. Before making the calculation, we need to isolate the data from the 5 specific vegetables. Table 2 tabulates the results.

In Table 2, *salvage value* on sales tomatoes is zero, because the vestige of sales of tomatoes are durable in 2 days. If more than 2 days, tomatoes will redden and then will be sold to restaurants.

Using the data from Table 2 and Table 3, the next step is to process the data using the Single Order Quantity method. This data process uses equations 4 and 5. Data is processed by calculating the value of  $F(Q_i|M_j)$ , where  $F(Q_i|M_j)$  is the outcome of following the demand strategy  $Q_i$ , when the actual demand is the state of nature  $M_j$ . The determination of outcomes can take two forms, depending on whether the amount ordered ( $Q_i$ ) is less than, or greater than the demand level ( $M_j$ ). Table 4 show the results.

Table 1. The Data Demand of Vegetables in Last Period.

Numb.	Product	Demand	Numb.	Product	Demand
1	ALOE VERA	1100	29	HYDROPONIC CURLY LETTUCE	5300
2	ALOE VERA (1000GR)	2250	30	HYDROPONIC CAISIM	7990
3	AVOCADO BUTTER	6400	31	HYDROPONIC ENDIVE LETTUCE	850
4	BIG ALOE VERA	2300	32	HYDROPONIC GREEN OAKLEAF	250
5	BIG CAULIFLOWER	6450	33	HYDROPONIC GREEN PACKCOY	2250
6	BOGOR NUTS	550	34	HYDROPONIC GREEN SPINACH	8800
7	BROCCOLI	2200	35	HYDROPONIC HORENZO	450
8	CABAI RAWIT MERAH	1250	36	HYDROPONIC KAILAN	2300
9	CAULIFLOWER	200	37	HYDROPONIC LETTUCE BUTERHEAD	650
10	CUCUMBER PICKLES	100	38	HYDROPONIC LOLLOROSA LETTUC	2300
11	CURAH RECENTO TOMATO	10850	39	HYDROPONIC RED SPINACH	6850
12	EDAMAME	26800	40	HYDROPONIC ROMAINE LETTUCE	2700
13	EDAMAME (500GR)	2300	41	HYDROPONIK KALE	7500
14	FRESH TOMATO	12200	42	LETTUCE HEAD	1100
15	GREEN CHERRY TOMATO	9700	43	ORGANIC PEA	300
16	GREEN CHILI	100	44	OYONG	300
17	GREEN SPINACH	27000	45	PARE	500
18	HEALTHY VEGET ORGANIC HORENZO	50	46	PEANUTS	4900
19	HEALTHY VEGET BEAN	500	47	PEELING SWEET CORN	4250
20	HEALTHY VEGET CAISIM	1150	48	RECENTO TOMATO	16650
21	HEALTHY VEGET CARROT	450	49	RED CHERRY TOMATO	30000
22	HEALTHY VEGET CHAYOTE	250	50	RED SPINACH	10100
23	HEALTHY VEGET GREEN PACKCOY	450	51	SWEET CORN SKIN	300
24	HEALTHY VEGET GREEN SPINACH	2000	52	TW TOMATO	21700
25	HEALTHY VEGET KALE	300	53	WHITE CABBAGE (5KG)	50
26	HEALTHY VEGET LEEK	850	54	WHITE CASSAVA	14850
27	HEALTHY VEGET RED SPINACH	1500	55	ZUKINI	5100
28	HEALTHY VEGET TOMATO	50			

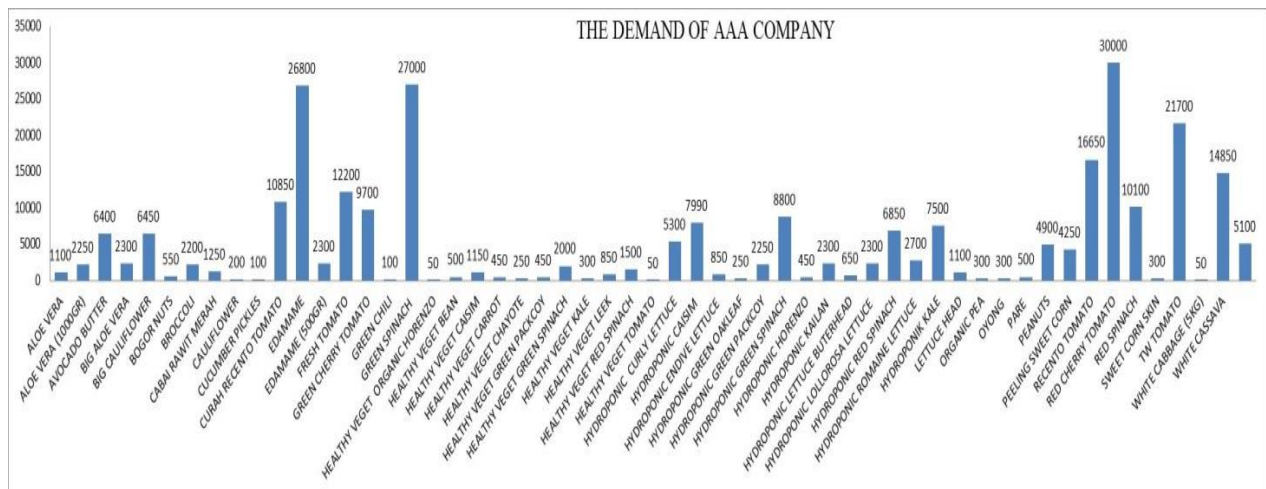


Figure 2. The Demand of Vegetables Consumer Chart

Table 2. Observation Result Data

Numb.	Product	Price	P <sub>1</sub> (unit selling price)	J (profit)	A (stockout cost)	I (salvage value)
1	Red Cherry Tomato	Rp 10,000	Rp 14,500	Rp4,500	Rp 4,500	Rp -
2	Green Spinach	Rp 3,500	Rp 11,500	Rp8,000	Rp 8,000	Rp 1,150
3	Edamame	Rp 10,000	Rp 18,500	Rp8,500	Rp 8,500	Rp 1,850
4	TW Tomato	Rp 13,000	Rp 18,000	Rp5,000	Rp 5,000	Rp -
5	Recento Tomato	Rp 15,000	Rp 21,000	Rp6,000	Rp 6,000	Rp -

Table 3. The Data Demand of Red Cherry Tomatoes.

Demand (M)	Number of Occurrences	Probability P(M)	Probability of Demand
50	16	0.340	0.660
100	1	0.021	0.638
150	1	0.021	0.617
250	3	0.064	0.553
300	3	0.064	0.489
350	3	0.064	0.426
400	3	0.064	0.362
500	1	0.021	0.340
550	2	0.043	0.298
600	1	0.021	0.277
700	2	0.043	0.234
900	2	0.043	0.191
950	1	0.021	0.170
1000	1	0.021	0.149
1100	1	0.021	0.128
1200	1	0.021	0.106
1400	1	0.021	0.085
1750	1	0.021	0.064
2750	1	0.021	0.043
3900	1	0.021	0.021
6150	1	0.021	0.000
<b>Total</b>	<b>47</b>	<b>1.000</b>	

Table 4 is based on processing data from red cherry tomatoes, chose the highest expected value to maximise profit. Profit is IDR 2.925.000 from 6150 packs of red cherry tomatoes.

Table 5. The Data Demand of Green Spinach.

Demand (M)	Number of Occurrences	Probability P(M)	Probability of Demand
50	5	0.625	0.375
100	2	0.250	0.125
26850	1	0.125	0.000
<b>Total</b>	<b>8</b>	<b>1.000</b>	

Using the data from Table 2 and Table 5, the next step is to process the data using the Single Order Quantity method. This data process uses equations 4 and 5. Data process do with calculating value of F (QiMj), where F (QiMj) is the outcome of following the demand strategy Qi, when the actual demand is the state of nature Mj. The determination of outcomes can take on two forms, depending on whether the amount ordered (Qi) is less than or greater than the demand level (Mj). Here is the result:

Table 6. The Data Process of Green Spinach used by the Single Order Quantity.

Strategy (Q)	Probability P(M)	0.625	0.250	0.125	Expected Value
		State of nature (M)			
		<b>50</b>	<b>100</b>	<b>26850</b>	
<b>50</b>		400000	0	-214000000	-Rp26,500,000
<b>100</b>		342500	800000	-213200000	-Rp26,235,938
<b>26850</b>		-3E+07	-3E+07	214800000	<b>Rp346,875</b>

The table based on the data process from the green spinach, chose the highest expected value to maximise profit. Profit is IDR 346.875 from 26850 packs of green spinach.

Table 7. The Data Demand of Edamame.

Demand (M)	Number of Occurrences	Probability P(M)	Probability of Demand
50	64	0.504	0.496
100	19	0.150	0.346
150	9	0.071	0.276
200	6	0.047	0.228
250	6	0.047	0.181
300	3	0.024	0.157
400	3	0.024	0.134
450	5	0.039	0.094
550	1	0.008	0.087
650	2	0.016	0.071
900	1	0.008	0.063
1000	2	0.016	0.047
1200	1	0.008	0.039
1300	1	0.008	0.031
1350	1	0.008	0.024
1800	1	0.008	0.016
2100	1	0.008	0.008
2450	1	0.008	0.000
<b>Total</b>	<b>127</b>	<b>1.000</b>	

Using the data from Table 2 and Table 7, the next step is to process the data using the Single Order Quantity method. This data process uses equations 4 and 5. Data process do with calculating value of F (QiMj), where F (QiMj) is the outcome of following the demand strategy Qi, when the actual demand is the state of nature Mj. The determination of outcomes can take on two forms, depending on whether the amount ordered (Qi) is less than or greater than the demand level (Mj). Table 8 below show the result.

Table 8 is based on the data process from the edamame, choose the highest expected value to maximum amount of profits. Who selected is IDR 262.618 with the number of edamame requests are 650 packs.



Table 9. The Data Demand of TW Tomatoes.

Demand (M)	Number of Occurrences	Probability P(M)	Probability of Demand > M
50	10	0.303	0.697
100	3	0.091	0.606
150	2	0.061	0.545
200	1	0.030	0.515
250	1	0.030	0.485
300	3	0.091	0.394
450	1	0.030	0.364
550	1	0.030	0.333
600	1	0.030	0.303
650	1	0.030	0.273
850	1	0.030	0.242
900	1	0.030	0.212
1000	1	0.030	0.182
1400	1	0.030	0.152
1650	1	0.030	0.121
2300	1	0.030	0.091
2450	1	0.030	0.061
3100	1	0.030	0.030
3650	1	0.030	0.000
<b>Total</b>	<b>33</b>	<b>1.000</b>	

Table 11. The Data Demand of Recent Tomatoes.

Demand (M)	Number of Occurrences	Probability P(M)	Probability of Demand > M
50	28	0.389	0.611
100	10	0.139	0.472
150	7	0.097	0.375
200	3	0.042	0.333
250	8	0.111	0.222
300	2	0.028	0.194
400	5	0.069	0.125
450	2	0.028	0.097
600	3	0.042	0.056
700	1	0.014	0.042
800	1	0.014	0.028
1700	1	0.014	0.014
3000	1	0.014	0.000
<b>Total</b>	<b>72</b>	<b>1.000</b>	

Using the data from Table 2 and Table 9, the next step is to process the data using the Single Order Quantity method. This data process uses equations 4 and 5. Data process do with calculating value of F (QiMj), where F (QiMj) is the outcome of following the demand strategy Qi, when the actual demand is the state of nature Mj. The determination of outcomes can take on two forms, depending on whether the amount ordered (Qi) is less than or greater than the demand level (Mj). Table 10 show the result.

Table 10 is based on the data process from the TW tomato, choose the highest expected value to maximum amount of profits. Who selected is IDR 3.333.333 with the number of TW tomato requests are 3650 packs.

Using the data from Table 2 and Table 11, the next step is to process the data using the Single Order Quantity method. This data process uses equations 4 and 5. Data process do with calculating value of F (QiMj), where F (QiMj) is the outcome of following the demand strategy Qi, when the actual demand is the state of nature Mj. The determination of outcomes can take on two forms, depending on whether the amount ordered (Qi) is less than or greater than the demand level (Mj). Table 12 show the result.

Table 12 is based on the data process from the recent tomato, choose the highest expected value to maximum amount of profits. Who selected is IDR 1.462.500 with the number of recent tomato requests are 3000 packs.

Table12. The Data Process of Recent Tomatoes used by the Single Order Quantity.

Strategy (Q)	Probability P(M)	0.389	0.139	0.097	0.042	0.111	0.028	0.069	0.028	0.042	0.014	0.014	0.014	0.014	Expected Value
	State of nature (M)	50	100	150	200	250	300	400	450	600	700	800	1700	3000	
50		300000	0	-300000	-600000	-900000	-1200000	-1800000	-2100000	-3000000	-3600000	-4200000	-9600000	-17400000	-Rp862,500
100		300000	600000	300000	0	-300000	-600000	-1200000	-1500000	-2400000	-3000000	-3600000	-9000000	-16800000	-Rp495,833
150		300000	600000	900000	600000	300000	0	-600000	-900000	-1800000	-2400000	-3000000	-8400000	-16200000	-Rp212,500
200		300000	600000	900000	1200000	900000	600000	0	-300000	-1200000	-1800000	-2400000	-7800000	-15600000	Rp12,500
250		300000	600000	900000	1200000	1500000	1200000	600000	300000	-600000	-1200000	-1800000	-7200000	-15000000	Rp212,500
300		300000	600000	900000	1200000	1500000	1800000	1200000	900000	0	-600000	-1200000	-6600000	-14400000	Rp345,833
400		300000	600000	900000	1200000	1500000	1800000	2400000	2100000	1200000	600000	0	-5400000	-13200000	Rp579,167
450		300000	600000	900000	1200000	1500000	1800000	2400000	2700000	1800000	1200000	600000	-4800000	-12600000	Rp654,167
600		300000	600000	900000	1200000	1500000	1800000	2400000	2700000	3600000	3000000	2400000	-3000000	-10800000	Rp829,167
700		300000	600000	900000	1200000	1500000	1800000	2400000	2700000	3600000	4200000	3600000	-1800000	-9600000	Rp895,833
800		300000	600000	900000	1200000	1500000	1800000	2400000	2700000	3600000	4200000	4800000	-600000	-8400000	Rp945,833
1700		300000	600000	900000	1200000	1500000	1800000	2400000	2700000	3600000	4200000	4800000	10200000	2400000	Rp1,245,833
3000		300000	600000	900000	1200000	1500000	1800000	2400000	2700000	3600000	4200000	4800000	10200000	18000000	Rp1,462,500

## 5. CONCLUSION

- (1) The data plotted from various selected vegetables: red cherry tomato, TW tomato, recento tomato, green spinach, and edamame have the greatest number of request compared to other vegetables. The highest requested vegetables are red cherry tomatoes with a demand of 30000 packs, green spinach with a demand of 27000 packs, edamame with a demand of 26800 packs, TW tomatoes with a demand of 21700 packs, and recento tomatoes with a demand of 16650 packs.
- (2) Profit obtained from red cherry tomatoes is as much as IDR 2.925.000 at any reservations when the demand is as high as 6150 packs. Profit obtained from green spinach is as high as IDR 346.875 at any reservations when the number of demand is as high as 26850 packs. Profit obtained from edamame is as high as IDR 262.618 at any reservations when the demand is as much as 650 packs. Profit obtained from TW tomatoes is as high as IDR 3.333.333 at any reservations when the demand is as high as 3650 packs. Profit obtained from recento tomatoes is as high as IDR 1.462.500 at any reservations when the demand is as high as 3000 packs.

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