THE IMPLEMENTATION OF ABC CLASSIFICATION AND (Q, R) WITH ECONOMIC ORDER QUANTITY (EOQ) MODEL ON THE TRAVEL AGENCY

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Abstract **-** To support customer loyalty programs, the travel agencies gave a souvenir to their customers. In one of the travel agencies in Jakarta, the demand for travel agency services could not be ensured. This had an impact on inventory items that were surplus to requirements. Inventory management was done by combining classifications ABC and (Q, R) with Economic Order Quantity (EOQ) model, which was usually used for uncertain demand. With "A" classification of the goods, two model (Q, R) scenarios were made and then simulated with software Arena. From these two scenarios, the results show that both have a tendency to decline, or the stockouts occur. However, the second scenario is more optimistic because a dummy variable is added the second scenario. Thus, the tendency is stable and does not decline.

Keywords: ABC Classifications, (Q, R) Classifications, Economic Order Quantity (EOQ)

I. INTRODUCTION

Along with the importance of the tourism sector in the economic growth in many countries, the researchers have conducted research on various aspects of the sector such as marketing, management, supply chain, and others. Travel agency, facing with increasing tourism products and also competing with other travel agencies, tries to improve the competitive advantage by delivering value to the customers. For example, they can give a souvenir to customers when the customers use the tourism products and services.

McGregor (1996) stated that tourism industry was dominated by Small and Medium-Sized Enterprises (SMEs), public sector organizations, and increasing numbers of operators and travel agents. Nevertheless, Welford *et al.* (1999) stated that tourism business not only saw the side of supply or demand but should also provide a strong signal between these two parts.

This research focuses on the souvenirs inventory management of a travel agency that has been established in Jakarta since 1967 and has more than 80 branches in Indonesia. Service products produced by the travel agency is airplane tickets booking, hotel bookings, currency exchange, travel documents, and others. In taking care of customers as well as the customer loyalty programs, the agency provides a variety of souvenirs in accordance with the purchased product.

There are two techniques used in inventory management. First, ABC inventory technique is a technique based on the idea that a small portion of goods in inventory represents the total value of money in inventory. ABC is a very popular method in categories based on number and value. Teunter *et al.* (2010) conducted a research based on the weight value like A = 50%, B = 30% and C = 20%. In 50%, it is categorized as category A that is the most significant, sensitive and requires special treatment. Starting from 50% to 80%, it is in category B. While, 80% to 100% is in category C. Understanding the character in an ABC inventory allows people to approach the selection of inventory management. Small group (group A) can be controlled more tightly as the representative of the whole inventory. The control with a lower level may be applied to B and C goods. Van Kampen *et al.* (2012) found that the classification of goods has been carried out in various industries. Meanwhile, Shen (2015) and Teunter *et al.* (2010) stated that the level of service is one of the determinants of cost savings and quality of service associated with inventory. Then, Eric *et al.* (2016) found that the use of a mathematical approach based on ABC classification and optimization model of Generic Algorithm (GA) provides optimal solutions. Syntetos and Keyes (2009) concluded that performance of ABC classification increases 95% of a Japanese electronics manufacturing companies in Europe. Moreover, Stanford and Martin (2007) showed that the ABC inventory classification system was the basis of a normative model to handle cost structure and characteristics of stock in a large inventory system with much stuff and constant demands. Teunter *et al.* (2010) suggested three simple steps in implementing the ABC classifications based on cost. While Farrukh *et al.* (2015) proposed five steps of ABC in SMEs. Roda *et al.* (2014) found that there were five main criteria in determining the classification commonly used in industry. They were cost, lead time, specificity, total demand, and unpredictable demand.

The second technique is Economic Order Quantity (EOQ). Most of the textbooks highlighting operations management provide inventory management to explore the basic Economic Order Quantity (EOQ) formula by Russell and Taylor (2011). It is important to know that EOQ can be applied to the situations with several circumstances. First, the demands are certain and constant over time. Second, the lack of items is not allowed. Third, the lead time is constant. Fourth, it is the number of orders received at one time. Fifth, there is fixed ordering cost in any orders. Sixth, the holding costs are charged for each stored item. EOQ is a measure that will minimize the total of ordering cost and holding cost. With these statements, it can be:

$$Q = \sqrt{2kD/h} \quad (1)$$

where,
Q = the number of orders
D = total annual demand
k = fixed costs per order
h = annual holding cost per unit

Currently, there are many researches in EOQ model. Chen and Zhuo (2010) explored a model inventory for the partial backlog. Krishnaraj and Ramasamy (2013) offered a model for EOQ consumption by experiencing the pace of decline linearly with delayed payment and with special discounts. Panda *et al.* (2009) found EOQ model for products that were easily damaged by the discount price and demand depending on the stock. Meanwhile, Tripathy *et al.* (2003) explored the EOQ model by considering the production process reliability. OuYang *et al*. (2003) suggested a model inventory to see the effects of inflation and the time value of money. Janamanchi (2011) concluded about the use of EOQ on the paradigm of e-commerce. Moreover, Rong (2011) analyzed EOQ model where ordering cost, lack of goods and holding the cost of the items were assumed to be an uncertain variable. Zinn and Charnes (2005) compared the method of QR (Quick Response) with EOQ that EOQ was still a viable option. Lee and Joglekar (2012) developed a model for EOQ inventory with a pricing strategy that was increasing continuously. Then, Sucky (2004) analyzed the model dealing with asymmetric information about cost structure by the buyer. Last, Kavishwar *et al.* (2014) got a reduction in operating costs on all small-scale textile mills by using EOQ.

Furthermore, one of the realistic models is (Q, R) model where the model is to deal with uncertain demand. This model is proposed by Axsäter (2006) and Taha (2007), which was later modified by Nakandala *et al.* (2014) in the form of algorithm iteration. Here is the algorithm:

Step 1, for every ordering cost (*k*), the specify value is $Q_{i0} = \sqrt{(2k_i d/h)}$. So, the iteration starts from EOQ.

Step 2 is to estimate the value of *R*. It is by finding the cumulative probability function of *R* with $F(R) = 1 - \frac{Q*H}{p*d}$ where *Q* is *Q* in the previous step, *p* is a stockout cost. Then, searching the *z* inverse value associated with right tail of *1-F (R)*. *R* is calculated by $R = L*d + \sqrt{L\sigma}*z$.

Step 3 is to find value *Q*... ,and *R*... , by getting theloss function $(L(z) = \int_z^{\infty}(t-z)(t)dt)$, calculating thelead time demand $n = \sqrt{L\sigma L(z)}$ and getting $Q = \sqrt{2d(K+pn)/h}$, and repeating step 2 to get final value of *R* *(j <= j + 1)*.

Step 4, if it is absolute value of $(Q_{ij}-Q_{ij} + 1) < 0.1$ and absolute value $(R_{ij} + 1-R_{ij}) < 0.1$, then iteration is stopped, or repeat step 3.

II. METHODS

Young and Nie (1992) stated that the results of ABC method are quite risky to the stockout, so it needed to be combined with other strategies such as cycle counting of EOQ. There are examples of the combination. First, Borle *et al.* (2014) merged EOQ method, ABC and Vital, Essential, Desirable (VED) in a Health Education Center resulted in saving of 25% of drug inventory cost. Likewise, Zhang *et al.* (2013) found the same thing in a maintenance support in Electronic Counter Measures equipment. Then, Burns *et al.* (2001) conducted a research of the inventory in a pediatric and found that ABC inventory analysis combined with EOQ model provided a framework that can be achieved, and determine the ordering cycle and size of the expensive components.

Therefore, the method used in this research has put a combination of ABC classification done by Teunter *et al*. (2010) with (Q, R) with EOQ model algorithm iteration by Nakandala *et al.* (2014). Next, the model will be simulated by using software Arena.

III. RESULTS AND DISCUSSIONS

First of all, the researchers classify all goods in ABC technique. The process begins by collecting available inventory data, unit price and average expenditure per year. Then, the data is processed by seeking the turnover value of each item. Next, the products are sorted by the greatest value to the smallest value. It can be seen in Table 1.

Table 1 ABC Categorization

Name of Goods	Percentage (%)	Weight (%)	Category
Adult Travel Bag	60,647%	60,647%	A
Folded Umbrella	8,051%	68,698%	B
Waist Bag	4,875%	73,573%	B
Mug	3,760%	77,333%	B
Tumbler	3,378%	80,711%	B
Premium Travel Bag	2,986%	83,697%	B
Paper Bag	2,826%	86,523%	C
Kid Travel Bag	2,683%	89,206%	C
Pen	2,432%	91,638%	C
Premium Wallet	1,419%	93,057%	C
Beauty Case	1,380%	94,437%	C
Luggage Tag	1,212%	95,649%	C
Wallet	0,921%	96,570%	C
Puring Bag	0,783%	97,353%	C
Wallet Luggage Tag	0,669%	98,022%	C
Passport Cover	0,529%	98,551%	C
Adaptor	0,450%	99,001%	C
Neck Pillow	0,418%	99,419%	C
Band	0,306%	99,725%	C
Big Umbrella	0,219%	99,944%	C
Premium Luggage Tag	0,056%	100,000%	C

Table 1 shows only 1 item in category A which is the adult travel bag. This item has the special feature that corresponds to A category. It has tremendous and turnover value and is also large. In addition, this item is also sensitive and requires special treatment in storage.

Then, (Q, R) model will be made on the adult travel bag consuming the most turnover in the company warehouse. The adult travel bag also has the high level of spending, but it tends to fluctuate. The expenditure levels have a pattern of the trend. Figure 1 shows the data of daily bag demand in 2015 without considering the holiday.

The bags withdrawal has a pattern of inclined trends in certain months. Therefore, a general formulation cannot be done. Judging from the movement of inventory of adult travel bag in Figure 1, the period will be divided into two types of scenarios. Scenario 1 is the scenario where the movement of goods is divided into three periods. This period grouping is not based on the division of the month but is the number of working days divided by 3. Meanwhile, scenario 2 is where the movement of goods is divided into several specific periods while monitoring the pattern of movement and the deviation of goods. In this grouping, each period could have some different days. However, it still considers the minimum sample of 30 days.

In scenario 1, there are 256 working days in 2015. The divisions are period 1 from the beginning of January 2nd, 2015 to May 4th, 2015 with 85 days; period 2 starting from May 5th, 2015 until August 27th, 2015 with 85 days; and period 3 from August 28th, 2015 to December 28th, 2015 with 86 days. Moreover, Figure 2 shows the grouping of scenario 1 and Table 2 presents the summary of the data and the results of calculations of (Q, R) model.

From the calculation, it is found that Q in the period 1 to 3 are 679, 870, and 693 consecutively. For R in the period 1 to 3 are 1132, 1823, and 1195. There is an interesting pattern in the results. The value of R is always greater than Q. There are some assumptions that can be drawn from the results. First, the standard deviation level is too high, so the calculation shows how to play secure like storing as much as possible. Second, period 2 has the highest level of discrepancy between Q and R (1:2). It can be concluded that the decision to store more ensures the secure number of goods. Moreover, the high level of deviation is also due to peak season.

In scenario 2, the solution is based on the optimal value by dividing the movement patterns of data distribution as seen in Figure 3. This research is more concerned about the data distribution of daily pattern. Data is divided into five periods in accordance with the specified movement pattern of similar data based on the level of fluctuation, like the periods with low fluctuation and periods with high fluctuation. Thus, the calculation in this scenario can see the more predictable data and have a high level of confidence for the sub-period with low fluctuation.

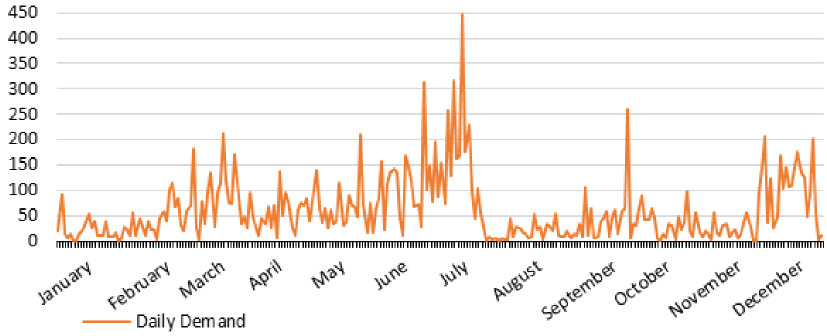

Figure 1 Rate of the Daily Cash Expenditures Based on Data in 2015

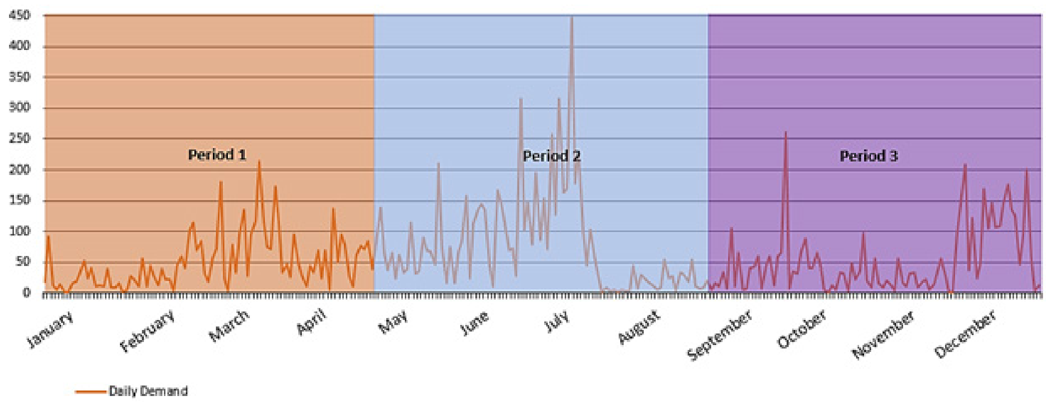

Figure 2 Grouping of the Period for Analysis in Scenario 1

Table 2 Summary of Data and (Q, R) Calculation in 2015

	Period 1	Period 2	Period 3
Mean	50,45	79,54	52,186
St. Dev (σ)	43,741	81,32	54,13
Variance	1913,275	6613,9	2930,86
Number of days	85	85	86
Expected demand during period (D)	4289	6761	4488
Demand during Lead Time (µ)	1009,176	1590,82	1043,72
holding cost (h) = 10000/year	2328,76	2328,76	2356,16
Set-up cost (k)		Rp120.000,00	
Stock-out cost (p)		Rp140.000,00	
Lead time (L)		20 days	
Reorder Point (R)	1132	1823	1195
EOQ (Q)	679	870	693

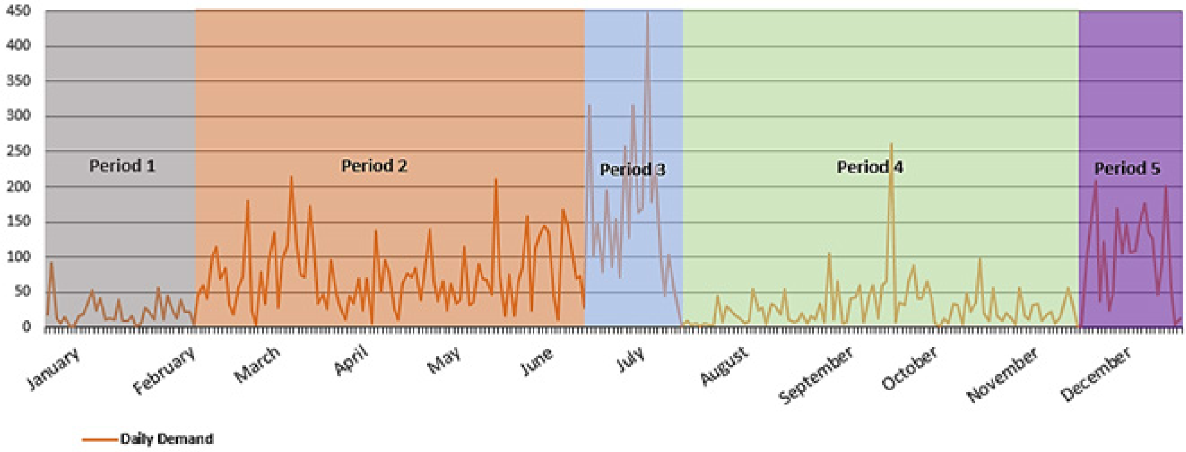

Figure 3 Grouping of the Period Based on the Pattern

Table 3 Summary of Data and (Q, R) Calculation in 2015

	Period				
	1	2	3	4	5
Mean	22,38	72,31	134,50	30,15	82,83
St. Dev (σ)	19,00	46,51	100,85	34,87	64,09
Variance	361,15	2163,28	10171,22	1215,73	4107,73
Number of Days	34	80	30	82	30
Expected demand during period (D)	761,00	5785,00	4035,00	2472,00	2485,00
Demand during Lead Time (μ)	447,65	1446,25	2690,00	602,93	1656,67
holding cost (h) = 10000/year	931,50	2191,78	821,91	2246,57	821,91
Set-up cost (k)			Rp120.000,00		
Stock-out cost (p)			Rp140.000,00		
Lead time (L)			20 days		
Reorder Point (R)	499	1579	2987	610	1841
EOQ (Q)	449	809	1116	497	871

The grouping is based on the pattern adjusted to the following periods. Period 1 starts from January 2nd, 2015 to February 21st, 2015 with 34 days. Period 2 is from February 23rd, 2015 until June 11th, 2015 with 80 days. Period 3 is from June 12th, 2015 until July 16th, 2015 with 30 days and period 4 from July 20th, 2015 until November 11th, 2015 with 82 days. While, period 5 begins from November 12th, 2015 until December 28th, 2015 with 30 days. Table 3 presents the summary of the data and the results of (Q, R) model calculations.

Briefly, in the period 1, Q and R are almost equivalent to a value of 449 and 499. In the period 2, there is a significant decline in the ratio between Q and R which is 809 compared to 1579. Meanwhile, the period 3 is with the largest value fluctuations with a larger comparison, 1117 and 2987. Then, period 4 has the ratio of Q and R value (497:610). Last, period 5 has a comparison value between Q and R which is 871 and 1841.

In this scenario, period 1 and 4 have a nearly equal ratio of 449:499 which is equal to 0,90, and 497:610 with an equivalent to 0,81. These values do not appear in the first scenario. It is due to the low value of the uncertainties in scenario 2 for period 1 and 4. For all periods of scenario 1, and period 2, 3, and 5 of scenario 2, they have considerable high deviation levels in demand. It is demanded that the stock safety and reorder point be placed on a high point to avoid the possibility of the stockout.

The measurement and verification of the results of the model (Q, R) require a significant time, and effort and resources to practice this activity. In this research, time is limited to verify directly. Therefore, the computational simulation is the appropriate methods to conduct verification tests on these results. The simulation is as seen in Table 4.

Table 4 Variables in Designing Arena

Scenario 1				
Period	Expression	Q	R	Iteration
1	2 + EXPO (48,5)	679	1132	85 day
2	2 + 212 * BETA (0,659, 1,5)	870	1823	85 day
3	2 + GAMM (72, 0,669)	693	1195	86 day
Scenario 2				
Period	Expression	Q	R	Iteration
1	2 + WEIB (5,44, 0,589)	449	499	34 day
2	2 + ERLA (37, 2)	809	1579	80 day
3	2 + 212 * BETA (1,38, 1.52)	1117	2987	30 day
4	2 + 212 * BETA (0,915, 6,85)	497	610	82 day
5	2 + 212 * BETA (0,247, 1,22)	871	1841	30 day

In this research the value of the initial inventory will use the sum of Q and R. In scenario 1 period 1, the simulation is conducted for 85 iterations. The initial inventory value is 1811. The statistics show poor results on the (Q,R) with EOQ model that there is a declining trend in the simulation. Through 5 repetitions, Figure 4 shows the results obtained from the simulation.

The calculation of (Q, R) with EOQ model in this period is less suitable to be used because of the declining trend. On the other hand, the minimum and maximum average of 5 repetitions show the lower numbers of R. This increases the risk of stockout like in the particular case of the stockout -1004. It suggests a substantial loss.

In scenario 1 period 2, the simulation is for 85 iterations. The initial inventory value is 2693. Then, the statistics show poor results on the (Q,R) with EOQ model that there is a declining in the simulation. Through 5 repetitions, Figure 5 illustrates the results obtained from the simulation.

The calculation of the (Q,R) with EOQ model in this period is still less appropriate to be used. There is a trend that continues to decline. This will increase the risk of stockout like in the particular case of the stockout (-1353). This implies a substantial loss.

In scenario 1 period 2, the simulation is performed for 86 iterations with 1888 as the initial inventory value. The statistics show poor results on the (Q,R) with EOQ model where there is a declining in the simulation. Through 5 repetitions, Figure 6 shows the results obtained.

Therefore, the calculation of (Q, R) with EOQ model in this period is less suitable to be used because of the declining. On the other hand, the average minimum and maximum average of 5 repetitions show lower numbers of R. This increases the risk of stockout. For example, in the particular case, the stockout is -1033. This may suggest a substantial loss. In summary, the value of inventory is described in Table 5.

In scenario 2 period 1, the simulation is for 34 iterations. Then, the initial inventory value is 948. The statistical data shows excellent results in (Q,R) with EOQ model. There is a trend that is likely to be stable in the simulation. Through 5 repetitions, Figure 7 shows the results obtained from the simulation.

Next, the calculation of (Q,R) with EOQ model during this period are very appropriate to be used. It is because there is a stable trend. During this period, the level of demand and fluctuation are very low. It is estimated that if this condition goes in a long time, the value of the inventory will be optimal with a low stockout condition.

In scenario 2 period 2, the simulation is conducted for 80 iterations. The initial inventory value is 2388. However, the statistics show poor results which there is a declining in the simulation. Figure 8 shows the results obtained through 5 repetitions from the simulation.

Moreover, the calculation of (Q,R) with EOQ model in this period is less suitable to be used since there is a declining trend. On the other hand, the average minimum and maximum average of 5 repetitions show a lower number of R, and the minimum average is negative. This results in a high risk of stockout. In the particular case, the stockout can be -2055. It implies a very large loss.

Meanwhile, in scenario 2 period 3, the simulation is 30 iterations with 4104 as the initial inventory value. The statistical data show poor results. There is a declining in the simulation. Through 5 repetitions in the simulation, the results are obtained. Figure 9 shows the results.

Based on that, the calculation of (Q,R) with EOQ model in this period is less appropriate to be used since there is a declining trend. There will be a high possibility of stockout in the long term. However, for a short time interval, the calculation can be considered.

Next, in scenario 2 period 4, the simulation is conducted for 82 iterations. The initial inventory value is 1107. From the statistical data, it shows poor results on the (Q,R) with EOQ model. There is a declining in the simulation, but it is conducted after a very long time. Thus, it is possible that this scenario is quite good. Figure 10 illustrates the results obtained.

It can be said that the calculation in this period is accurate enough to be used. Despite the declining trend, it runs very slowly. On the other hand, the minimum and maximum average of 5 repetitions deviate around R. The stockout risk may exist like in the particular case of stockout; it reaches -269. This results in a loss for the company.

Moreover, in scenario 2 period 5, 30 iterations are done for the simulation. The initial inventory value is 2712. In here, the statistical data show excellent results in the (Q, R) with EOQ model. There is a declining in the simulation, but it will require considerable time until the stockout. Through 5 repetitions, Figure 11 shows the results.

The calculation this period is good enough to be used. Although there is a declining trend, it takes a long time until stockout happens. Meanwhile, the minimum and maximum average of 5 repetitions are slightly lower than R. In this case, there is no stockout, but with a downward trend in the long term, it is expected to decline.

In scenario 1 and 2, the stockout risk could occur in any case. It also decreases for various simulation. However, the result of scenario 2 is more optimistic. To avoid the results, the simulation will be carried out with the dummy variable. The simulation is based on the variables of scenario 2 in which the stockout occurs. The dummy variable will put Q value into the simulation model in the time between ordering and order release. Thus, in this simulation, the lead time will be matched with 10.

In the simulation process of period 2, some of the variables used are: Q = 809, R = 1579, and demand function = 2 + ERLA (37, 2). The iteration is done within 80 days. The result is shown in Figure 12.

Meanwhile, in the simulation process of period 4, some of the variables used are: Q = 497, R = 610, and demand function = 2 + 212 * BETA (0,915; 6,85). The iteration is done within 82 days. Figure 13 shows the result.

The result with dummy variables is better than others. Through 5 repetitions, the value stockout happens minimally. In addition, the trend tends to be stable for the long term.

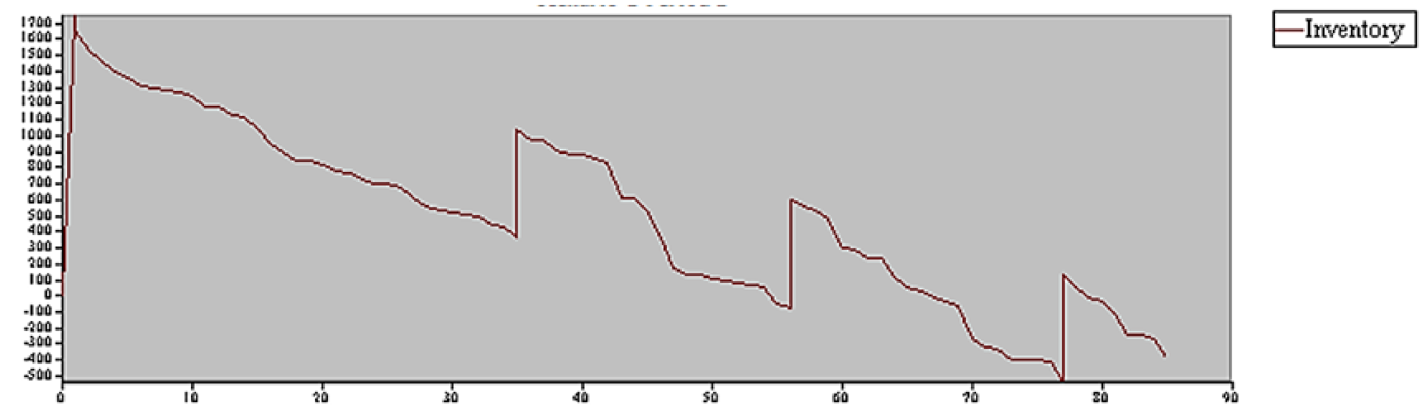

Figure 4 Movement of Inventory in Scenario 1 Period 1

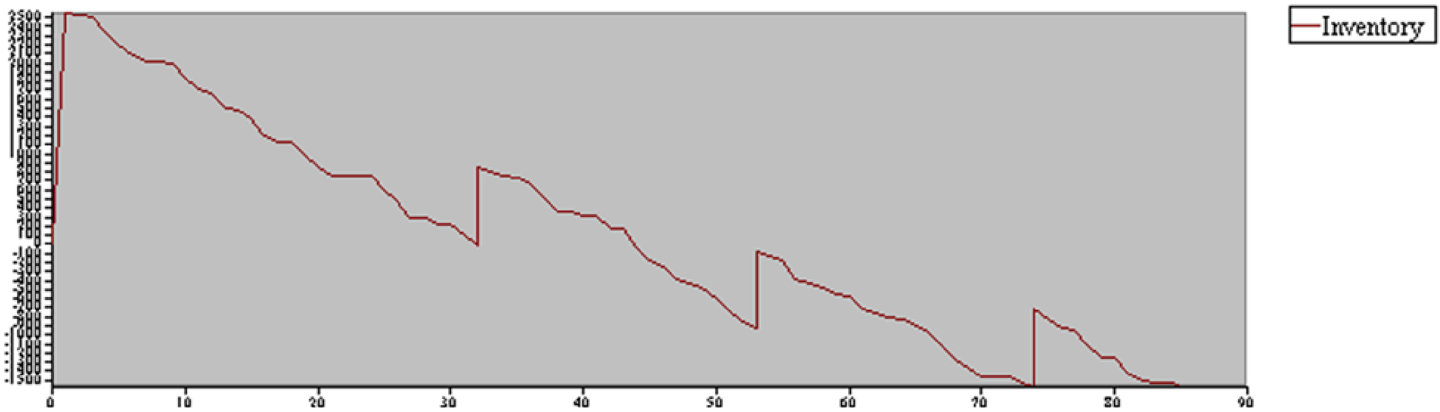

Figure 5 Movement of Inventory in Scenario 1 Period 2

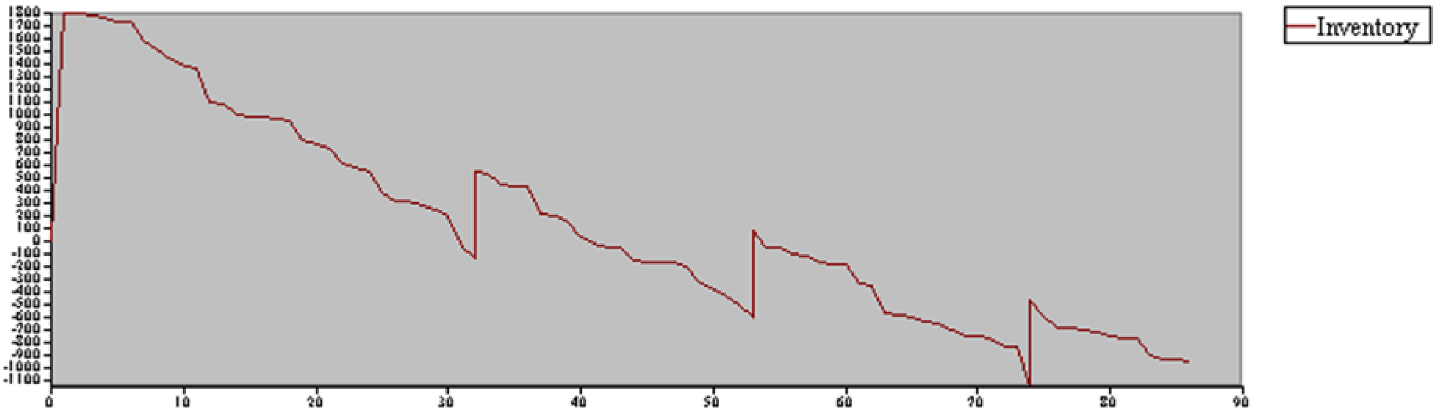

Figure 6 Movement of Inventory in Scenario 1 Period 3

Table 5 Value of Inventory Simulation Scenario 1

Variable output	Period 1	Period 2	Period 3
Average	353,27	699,9	426,08
Minimum Average	110,4	294,8	221,48
Maximum Average	574,55	965,65	688,95
Minimum Overall	-1004	-1353	-1033
Maximum Overall	1802	2686	1880,42

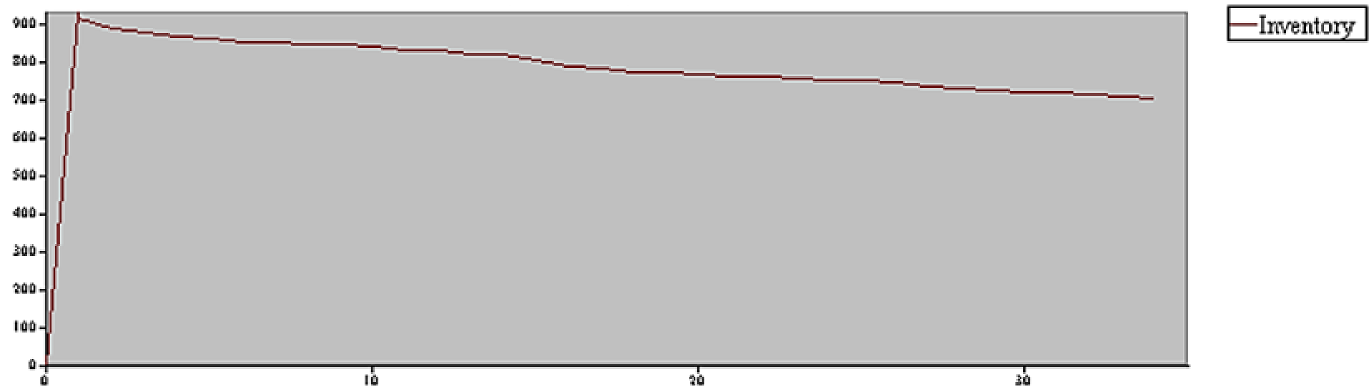

Figure 7 Movement of Inventory in Scenario 2 Period 1

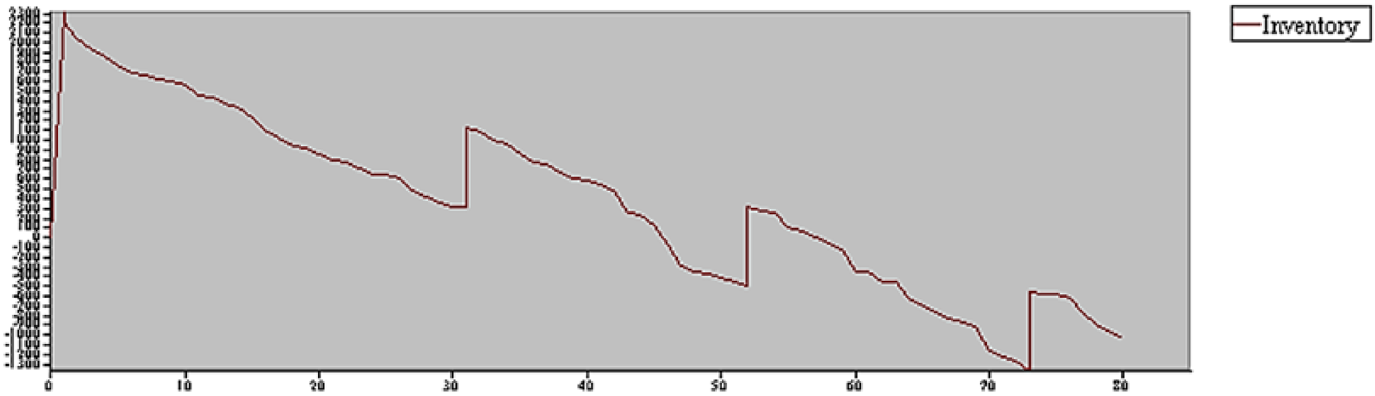

Figure 8 Movement of Inventory in Scenario 2 Period 2

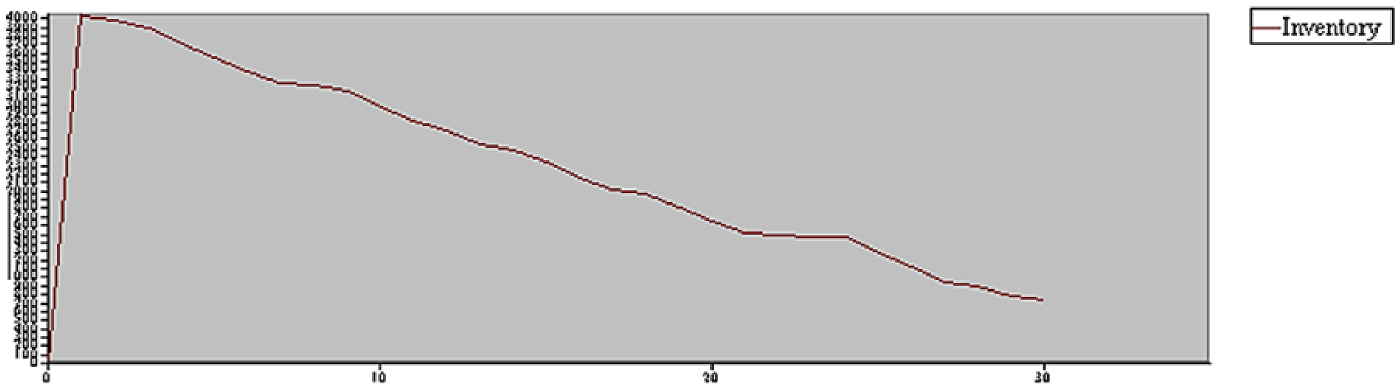

Figure 9 Movement of Inventory in Scenario 2 Period 3

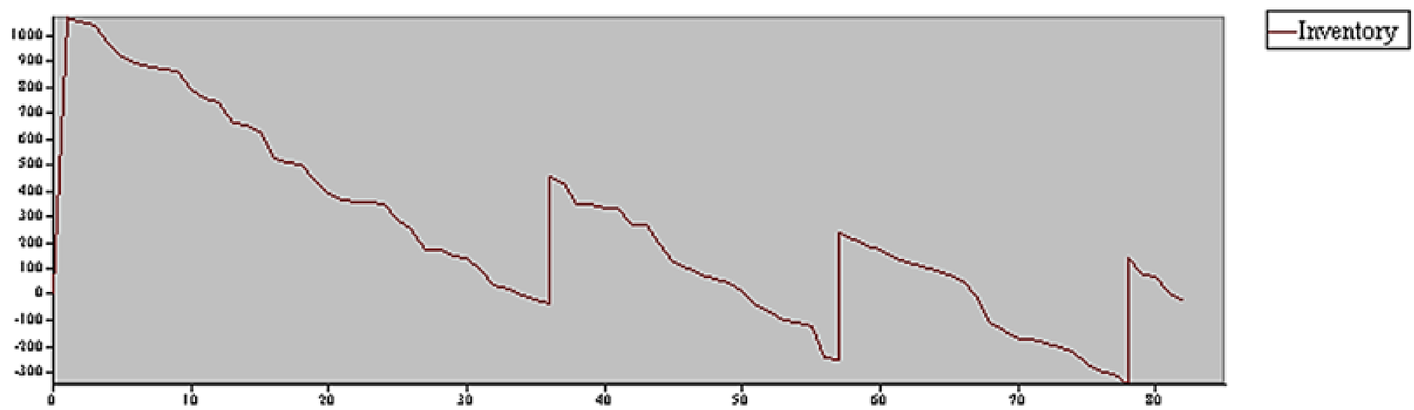

Figure 10 Movement of Inventory in Scenario 2 Period 4

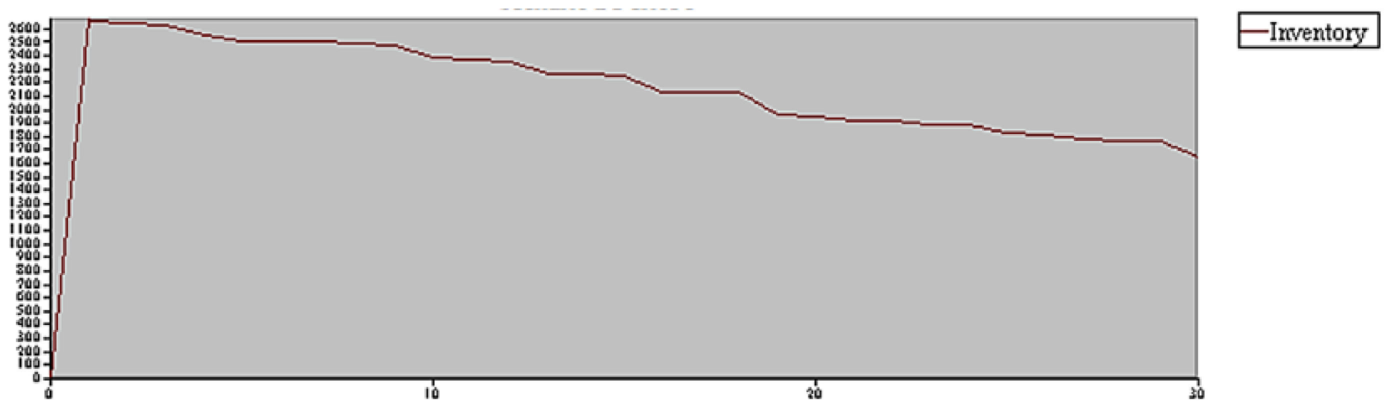

Figure 11 Movement of Inventory In Scenario 2 Period 5

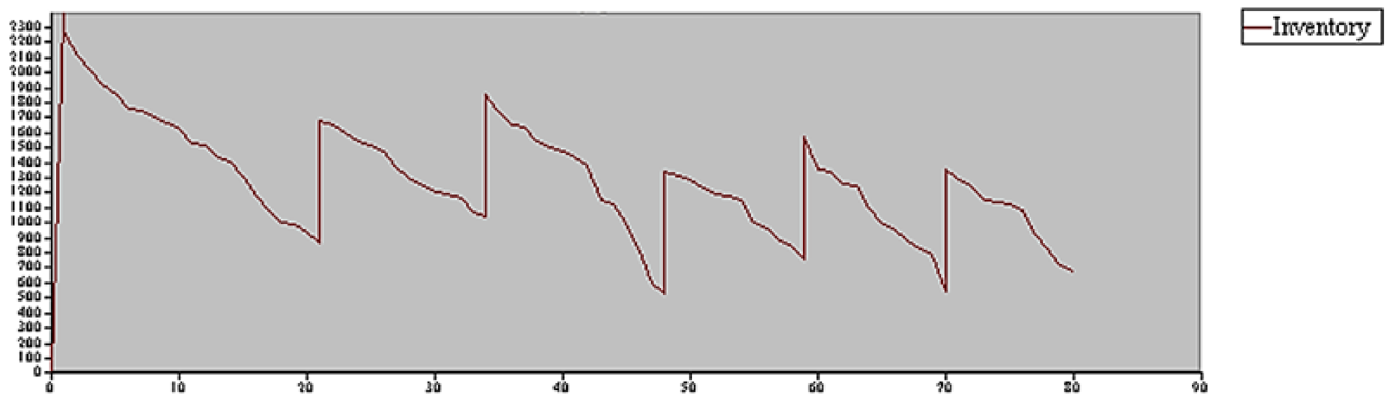

Figure 12 Movement of Inventory in Period 2 by Using Dummy Scenario

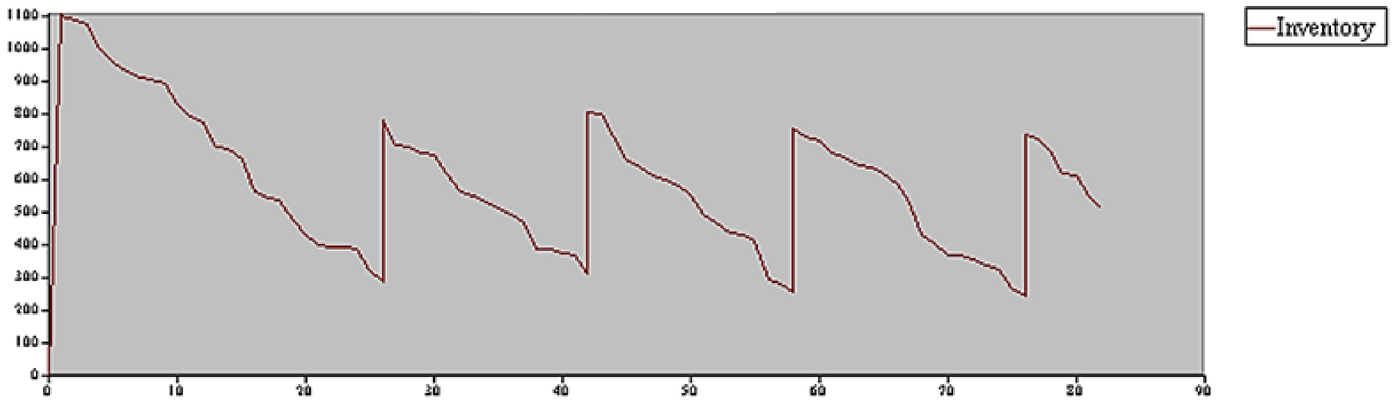

Figure 13 Movement of Inventory in Period 4 with Dummy Scenario

IV. CONCLUSIONS

This research may help to reduce the value of inventory in moving and rotating in the company. Technically, the suggested method is also quite easy to do where the warehouse can review the actual amount of goods and make a reservation when the goods are already in the point R. However, to follow up the results of this research, the companies need to confirm with the vendor related to the readiness to serve the partial order, which differs from the methods currently applied, and the consistency to follow the service level in the procurement of the goods.

This research introduces knowledge to the industry regarding the inventory of tourism services as well as a means to explain the importance of managing good inventory. It can save costs and improve the inventory performance. Hopefully, through this research, the tourism industry may consider the inventory as one step in the continuous improvement. On the other hand, the research also implies that the excessive inventory has an impact on the environment.

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