GROSTLOG 2018
Global Research on Sustainable Transport & Logistics

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

Inventory Allocation for Offline and Online Stocks for Fashion Industry

S.Sarifah Radiah Shariff [1], Shahrul Irda Said [2]
[1]Malaysia Institute of Transport (MITRANS), Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia. [2]Centre for Statistics and Decision Science, Faculty of Computer & Mathematical Sciences, Universiti Teknologi MARA, Shah Alam, Selangor, Malaysia.
Corresponding Author: radiah@tmsk.uitm.edu.my

Abstract

Fashion Industry is a fast moving industry that is always related to the demands and trends. In this industry, the fashion retailer's supply chain covers the whole process flow of a product from the supplier or the vendor to the retailer as well as sales to the consumers. Nowadays, most retailers in fashion industry have both online and offline selling platforms. Hence, the right stock allocation for both online and offline is very important. When the allocation is not properly managed, product might not be able to be shipped even though it is physically available in the warehouse. The same scenario might happen in offline store where there are not enough stocks to cater to the walk in customer especially during promotion and special launches. The failure in managing the inventory properly will result in the loss of sales and lead to customers' loss of interest. In this study, the right allocation for both online and offline stocks is proposed through simulation technique which is based on the average probability of the current stocks demand for both online and offline ratio. The simulation results are then used to calculate the total inventory cost. It is shown that the total costs are comparable for current and proposed approach but the stock out possibility is minimized in the proposed allocation.

Keywords: Fashion Industry, online and offline business, inventory management, simulation for ratio

Introduction

Fashion retail is an industry that is particularly focusing on the clothing or attire, foot wears and also on accessories. The fashion retail industry is characterized by short lifecycles since the industry's product is based on fashion trends and consumer's demands, with an intensive and numerous competitions together with the presence of fickle consumers. The fashion industry is a very competitive industry but then again it has a market value of several hundred billions of dollars worldwide.

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

Globalization has accelerated the worldwide e-commerce while the internet nowadays is the driving force for the inter-connected supply chain that enables the business-to-business (B2B) development. Both business-to-business (B2B) and E-commerce are similar as the commercial platform in business but are totally different in the process. The business-to-business (B2B) is more direct to the customer while the E-commerce is a complex process. E-commerce involves an extreme coordination between entities from the start of ordering to the end of delivered product. While the offline fashion retail is defined as the process of selling products through a storefront location in-person, the retailers generally permit the patrons to try in the products prior to purchase at the same time offering the professional fitting services. Swani et al. (2017) stated that the Online-to-offline commerce or known as O-2-O is the business strategy that brings the potential customer's from online channels to the physical stores itself. This shows the strength of offline method as compared to the online. In this process, the customers are identified in online space through emails and through the online advertising.

All businesses are trying to strike a well balance in its' inventory between what is needed and what is demanded at the market but at the same time also considering the major factor of cost cutting and/or cost reduction, whether in the cost of product or operational processes (Johnson & Whang, 2002). In fashion retail, the inventory management focuses on the capacity of the inventory and the place in which it is located in fulfilling the customers demand (Preuss, 2013). Thus, a retailer must have a systematic way in order to truly manage and has the ability to control the inventory across all their sales channels (Jones & Kim, 2010). A great technology can be transformational to a business but it must be executed correctly. Beside great technology, demand forecasting can help in the business as restock can be done in time by calculating the reorder point levels and alerting for the new restock.

An appropriate stock allocation and replenishment is always a massive issue in the fashion retail. This is due to the current trend of having both online and

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

offline selling. If the stock allocation between both online and offline is not properly managed, product might not be able to be shipped even though it is physically available in the warehouse. This might result in loss of sales and lead to customer loss. The stock allocation between online and offline is a dynamic process as the demand might change inter changeably. Hence, the current timely allocation is really critical in order to ensure the maximum profit (Caro & Gallien, 2010; Doherty & Chadwick, 2010).

In the early days, retail activities were simple markets where the traders sold their merchandises or products to the local people. Even though these were basic operations, these activities were very important to the economy of the local government. They were also regulated by the authorities. Today, retailing involves companies engaging primarily in buying goods from other companies in order to resell these products to the customer where these companies resell the product through retail establishment called shops or stores.

The strategic safety stocks allocation expedite the decision making with regard to lean strategy by reducing the inventory level and having an agile and prompt strategy. This can be done by increasing the amount of product variety and outputs. Other steps are on the responsiveness level that can be done by reducing the numbers of customer order queues. These steps are taken when the framework of mapping out a dynamic and structured approach for developing a speed supply chain is understood in a systematic manner (Yohanes et. al, 2010). The increased number of retailers in the supply chain benefits from risk pooling and the economies of scale.

The fluctuation of demand causes the difficulties for the company to handle customers' orders using the traditional way based on the retailer's experiences. This will result in high inventory cost and the delay in fulfilling the orders. Some of the designed objectives of the optimization in inventory are focused on optimizing the strategies, and at the same time enhancing customer service, reducing lead-time and costs; and meeting market demand (Radhakrishnan & Jeyanthi, 2013).

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

The inventory level contributes remarkably towards the increase of supply chain cost. It is possible to minimize the supply chain cost by maintaining the optimal stock levels that are predicted from the inventory analysis. Thus, the right allocation method needs to be ventured into in order to address this issue. The use of simulations for inventory analysis is always an important topic in simulations literature. The objective of using the simulation is to optimize the inventory system parameters. The parameters are usually the reorder points, and also the order levels in inventory system. There is a myth saying that computational approaches for inventory are expensive (Sezen and Kitapchi, 2007). Hence, the simulation models are used in practice for managing an inventory (Liu et al ,2013). Direct Simulation Analysis (SA) scheme is the testing of the change in model output that follows a change in the parameters when they are shifted within the limits of their variation ranges (Borgonovo & Peccati, 2007).

Methods

The study was divided into four (4) phases: data collection, trends and demands analysis, ABC analysis followed by the sensitivity analysis through simulation.

Setting of the study

The study took place in one of Malaysian Fashion Retailer, XX Company that is located in Kuala Lumpur. The company started its operation in the year 2010 and now is one of the pioneers in online store for fashion industry that are now currently in the market. As time passed and with all new competitors were coming into the market, the company also enrolled in offline industry by selling the products in most of major high end shopping stores in the heart of Klang Valley in the year 2016.

Since starting its operation in 2010, there have been a lot of items being introduced and also being terminated by the company. There were few brands that were attached to the company and later became their own in house brands. All attached brands had their own contract duration based on joining date and once

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

they detached themselves from the company, whatever stocks left were returned to the vendor/brands and considered as inactive items in the inventory system. This inventory was not deleted as the details of the transactions were still needed for the reporting and reference. There was also a possibility for the brands to return to the company and the item would be reinstated as active items. Hence, there was a need to identify active items for this study and the best items to select were the in-house brands as they were the company own brands.

The inventory level of a certain selected in-house fashion brand that had high inventory stock movement in fashion retailer warehouse was identified. The identification was based on the status of the fashion brands whether it was active or inactive in sales activities. Only active brands from the year 2015 up to present were selected.

After the active items were identified, the sales volume data of each item needed to be compiled. The sales transaction of the selected items was generated to be compiled together with inventory status. Upon compilation, the analysis was carried out in order to check on the trends and inventory demands. The main objective of this study was to propose a suitable inventory profiling ratio that could cater both historical online and offline trends. Therefore, the related variables to inventory management were collected.

Data Description

The data for this study were generated directly from the fashion retailer's database. The data were integrated from both online and offline sales channel via integrated database. The inventory was then categorized based on the item types and brands. The data were collected based on the monthly basis sales transaction and inventory flow from November 2016 up to May 2017. The data consisted of Product SKU (Item Identification), Products Category, Online Sales Amount and Quantity, Offline Sales Amount and Quantity and Open Stocks Quantity for both online and offline channel.

More than 200 brands were currently attached to these retailers. However, due to the inventory control issue and contract durations of the brand, only in-

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

house brands were selected. This was to make sure that the historical data could be collected from the selected brands throughout the study. A sample of the data was summarized in Table 1.

Table 1. Sample Raw Data from database

					(in pcs)	
SKU	**Colour**	**Category**	**Brands**	**Total Stock**	**Stock Online**	**Stock Offline**
10019101602	Nude	Skants	FVB	207	123	84
10019101603	Navy	Skants	FVB	237	152	85
10019101601	Black	Skants	FVB	217	144	73
1523011720	Nude	Top	AR	108	63	45
10017011701	Blue	Jeans	FVB	280	236	44
10017011702	Blue	Jeans	FVB	299	255	44
66403021708	Black	Pants	DHFV	103	63	40
1522061506	Blue	Pants	AR	83	44	39
10005011702	Purple	Blouse	FVB	137	92	45
10010011701	White	Culottes	FVB	106	59	47

Out of the total fashion brands attached to the retailers, there were six (6) brands selected from the in-house fashion brands. The selected brands were AR, DHFV, FVB, MM, SM and TV. There were in total of 1,505 items selected from these six (6) in-house fashion brands with a total of 256 items from fashion brand AR, 26 items from DHFV, 655 items from FVB, 397 items from MM, 140 items from SM and 31 items from TV.

Out of 1,505 items, Brand FVB had the highest SKU with the percentage of 43.52% that nearly catered half of the selected items. The reason was that FVB was one of the active brands that was productively in demand in large quantity.

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

Besides FVB, the other brands that had higher inventory were MM and AR with 26.38% and 17.01% respectively. The distribution of Total SKU based on the brands was shown in Table 2.

Table 2. Total Items by Brands

Brands	Total SKU	%
AR	256	17.01%
DHFV	26	1.73%
FVB	655	43.52%
MM	397	26.38%
SM	140	9.30%
TV	31	2.06%
Total	**1,505**	

ABC Analysis

In this study, Group A remarked 70% from the total items; while group B and group C remarked as 20% and 10% from totals. The items were sorted based on the highest demands and calculated as follows:

Demand = Total Sold Quantity x Cost Price

Determining Ratio For Online And Offline Stocks Using Sensitivity Analysis

A sensitivity analysis is a technique used to determine the impact of different values of an independent variable to a particular dependent variable under a given set of assumptions. The technique is used within specific boundaries and it is depending on one or more input variables, such as the effect that changes in inventory level based on sales volume. The average number of the items in online and offline platforms was calculated in order to get the online and offline ratio. The calculation is as per below:

$$\text{Ratio Online (Average)} = \frac{Stock\ Online}{Total\ Stock}$$

$$\text{Ratio Offline (Average)} = \frac{Stock\ Offline}{Total\ Stock}$$

The total average stocks from online and offline could now become a current

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

inventory ratio. This was due to the assumption that, the items in Group A brought a bigger effect to the inventory as they were in top ranking items.

In Table 3, the average of the stocks was calculated where it was shown that the average ratio for online stocks allocation for the item in group A was 0.65 while for Offline the ratio was 0.35. This ratio was used as inventory allocation ratio that was used currently as reference to the study.

Table 3. Sample on the Online and Offline Average Ratio

SKU	Brands	Cost Price (MYR)	Online			Offline		
			Holding Cost (MYR)	Stock (pcs)	Average	Holding Cost (MYR)	Stock	Average
1	SM	229.00	10,534.00	46	0.85	1,832.00	8	0.15
2	FVB	168.87	43,061.85	255	0.85	7,430.28	44	0.15
3	FVB	93.40	7,285.20	78	0.86	1,214.20	13	0.14
4	SM	169.00	10,647.00	63	0.86	1,690.00	10	0.14
5	FVB	140.57	10,683.32	76	0.86	1,686.84	12	0.14
6	SM	229.00	11,679.00	51	0.86	1,832.00	8	0.14
7	FVB	93.40	7,191.80	77	0.87	1,120.80	12	0.13
8	FVB	140.57	12,791.87	91	0.88	1,827.41	13	0.13
9	FVB	140.57	12,089.02	86	0.89	1,546.27	11	0.11
10	AR	140.00	11,760.00	84	0.90	1,260.00	9	0.10
Total			2,836,042.11			1,552,250.12		
Total Holding Cost			**4,388,292.23**					
Ratio			**0.65**			**0.35**		

Inventory Simulation

Simulation is an attempt to duplicate the features, appearances and characteristics of a real system by imitating the real situation mathematically. Upon imitation, the properties and the characteristics of the operations are being

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

studied and conclusion is made based on the analysis.

Table 4 shows the sales simulation for 10 items from group A on May 2017. The daily sales for these items were tracked based on number of transaction (number of order) and sold quantity. The frequency of these items being ordered was tracked by taking the average stock online and offline. From the total stock, then the average number was obtained as the ratio.

The frequency of the order based on number of order was then used for the next step. The model was constructed based on the variable. As for this study, the relationship between stocks allocated to online and offline was looked into. The daily online and offline stocks and order frequency were obtained for those items that had transactions in the selected month. The possible courses of action were set up by specifying the values of the variables. In this study, frequency of order based on random number and the number of item for each order was calculated randomly based on the accumulated probability and random number interval.

Upon completing the sales simulation, the next simulation was the inventory simulation. In this step, the closing inventory as on 30th April 2017 of the selected items was used as opening balance for the simulation. Based on the simulated demands that were obtained from previous simulations, the balance of stocks was used to get the inventory holding cost at the end of the month. The holding cost formula was:

Total Holding Cost = Inventory Stocks x Item Cost

The final total inventory cost for these 10 items from simulation was analysed and compared. The average ratio from the simulation was used to compare with current practice average ratio. In order for the selected method to work, the ratio of simulated item should be either balance or less in variance compared to current ratio which was 0.68 and 0.32 respectively. Other measurement to look into was on the total holding cost. The simulated inventory holding cost should be less than the current inventory stocks.

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

Results and discussion

The ABC analysis was carried out in this study in order to determine the category of each item. The total (offline and online) sold quantity and sales valuewas 70 %, 20%, and 10%. As for ABC by Sales Value, out of 1,505 items, there were 361 SKUs which belonged to category A which fulfilled 70% of demand. Meanwhile 273 and 871 SKUs belonged to group B and C, respectively, as summarized in Table 4.

Table 4. Total Sold Quantity by Group (Sales Value)

Group	No of SKU	Percentage
A	361	23.99%
B	273	18.14%
C	871	57.87%
Total	**1,505**	

Determining Ratio For Online And Offline Stocks

Upon completing the ABC analysis, the item in group A was then selected to be analyzed via sensitivity analysis. In order to determine the ratio, the simulation based on the previous stocks data was made. From Table 5, it shows that, the current stocks average allocation ratio is between 0.65 for online and 0.35 for offline. Out of 140,441 stocks in total, 92,021 stocks are allocated to online and the rest of it which is 35% from the total stocks is allocated to the offline. It shows that very large number of stocks is allocated based on current rules of thumbs.

Table 5. Stocks Allocation Ratio

	Stock(in pcs)	Cost (in MYR)	Average Ratio
Online	92,021	12,762,189	0.65
Offline	48,420	6,990,795	0.35
Total Stock	**140,441**	**19,752,985**	

After completing the stock allocation simulation, the next step was to conduct the inventory simulations. Both simulated transaction refers to the number of order

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

and simulated items bought for transactions. For this study, only ten (10) items were selected based on highest transaction item made on May 2017 for online. Table 6 shows the result after the inventory simulation for online and offline items was applied. For online simulation, the current total inventory value is MYR 101,647.71 while after the simulation the total is MYR 100,408.89. It shows some decreasing in the total inventory value of MYR 1,238 or 1.21%.

In the offline inventory simulation, the total inventory value for current stocks is MYR 66,268.98 and after simulation, the total inventory value decreases at MYR 63,032.33. The variance of both current inventory values with simulation is MYR 3,236.65 or 4.84%.

Table 6. Stocks Allocation Ratio based on Simulation

Item	Cost (in MYR)	Online				Offline			
		current		simulation		current		simulation	
		Total Stock (in pcs)	Total Inventory Value (in MYR)	Total Stock (in pcs)	Total Inventory Value (in MYR)	Total Stock (in pcs)	Total Inventory Value (in MYR)	Total Stock (in pcs)	Total Inventory Value (in MYR)
1	112	262	29,412.12	115	12,917.59	128	14,369.28	87	9,809.17
2	99	68	6,732.00	92	9,153.65	33	3,267.00	10	990
3	112	92	10,327.92	112	12,571.37	32	3,592.32	86	9,671.56
4	139	87	12,093.00	77	10,684.24	32	4,448.00	45	6,228.90
5	159	78	12,435.54	123	19,629.35	28	4,464.04	69	10,995.73
6	139	90	12,510.00	65	9,074.38	32	4,448.00	62	8,681.39
7	99	42	4,158.00	62	6,186.66	32	3,168.00	11	1,057.81
8	112	42	4,714.92	62	6,966.94	43	4,827.18	84	9,420.10
9	129	37	4,773.00	55	7,124.34	20	2,580.00	27	3,421.50
10	65	69	4,491.21	94	6,100.37	32	2,082.88	42	2,756.17
Total Sub Inventory Cost (in MYR)		867	101,647.71	858	100,408.89	412	47,246.70	523	63,032.33
Total Stockout Cost (in MYR)							**19,022.28**		
Total Inventory Cost (in MYR)		**867**	**101,647.71**	**858**	**100,408.89**	**412**	**66,268.98**	**523**	**63,032.33**

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

Table 7: Inventory Simulations (Total)

Business Type	Current	Simulation	Ratio
Online	101,647.71	100,408.89	0.61
Offline	66,268.98	63,032.33	0.39
Total Inventory (in MYR)	**167,916.69**	**163,441.22**	**100**

Conclusions

In fashion industry, the ability to fulfill the customer's demand is the main criteria for the retailer to sustain in the market. An appropriate stock allocation and replenishment is a massive issue in the fashion retail due to the current trend of having both online and offline selling, If the stock allocation between both online and offline is not properly managed, product might not be able to be shipped even though it is physically available in the warehouse. The stock allocation between online and offline is a dynamic process as the demand might change inter changeably. Based on simulations on the previous sales transaction, this study finds that the proposed allocation ratio to be used is 0.65 for online stores and 0.35 for the offline stores. From the sales and trends analysis, offline sales has also contributed to increase sales even though the stocks allocated to the offline store are only 35% of the total stocks.

References

Borgonovo, E. & Peccati, L. (2007). Global sensitivity analysis in inventory management. *Int. J. Production Economics*, pp. 302–313

Caro, F. & Gallien, J. (2010). Inventory Management of a Fast-Fashion Retail Network. *Journal of Operations Research,* vol. 58, pp. 257-273.

Doherty & Chadwick (2010). Internet retailing: the past, the present & the future. *International Journal of Retail & Distribution Management*, Vol. 38 Issue: 11/12, pp.943-965.

Johnson, M. E., & Whang, S. (2002). E- business and supply chain management: an overview and framework. *Production and Operations management*, *11*(4), 413-423.

ISSN: 2622-5778 (online)
Advances in Transportation and Logistics Research
http://proceedings.itltrisakti.ac.id/index.php/atlr

Jones, C., & Kim, S. (2010). Influences of retail brand trust, off- line patronage, clothing involvement and website quality on online apparel shopping intention. *International Journal of Consumer Studies*, *34*(6), 627-637.

Liu, Q, Zhang, X , Liu, Y. & Lin, L. (2013). Spreadsheet Inventory Simulation & Optimization Models & Their Application in a National Pharmacy Chain. *INFORMS Transactions on Education*, vol. 14(1), pp.13-25.

Preuss, C. (2013). Retail Marketing & Sales Performance: A Definitive Guide to Optimizing. *Springer Gabler.*

Radhakrishnan P. & Jeyanthi, N. (2013). Application of Genetic Algorithm to Supply Chain Inventory Optimization. *Journal of Contemporary Research in Management.* pp. 418-422

Sezen, B., & Kitapci, H. (2007). Spreadsheet simulation for the supply chain inventory problem. *Production Planning and Control*, *18*(1), 9-15.

Swani, K., Milne, G. R., Brown, B. P., Assaf, A. G., & Donthu, N. (2017). What messages to post? Evaluating the popularity of social media communications in business versus consumer markets. *Industrial Marketing Management*, *62*, 77-87.

Yohanes K., Petri, H. & Takala, J. (2010). Strategic Inventory Allocation for Product Platform Strategy. *Journal of Advances in Management Research.* pp.233-249.