

Study on Inventory Management Optimization of Small and Medium-sized Retail Companies in the Context of New Retail: Based on AHP

Zhou Chuanpeng^{1*}, Zhang Yi²

¹School of Management, Shandong University of Technology
Zibo, China

²Management College Of OUC
Qingdao, China

*Corresponding author's email: zhouedu [AT]vip.163.com

ABSTRACT---*The emergence of "New Retail" produces a great impact on the inventory management of retail companies. Using ASY company as the study object, this paper calculates weights of factors affecting inventory management with the Analytic Hierarchy Process (AHP) method to obtain the weight data of each factor before and after the New Retail appears. On this basis, it analyzes how New Retail affects the inventory management of ASY company. Besides, it offers optimization strategies and effect feedback indicators for the following problems faced by this company: pay less attention to delivery method and management system; poor incentive policies for employees; lay less stress on FMCG; too many goods are distributed by manufacturers; heavy workload; increased impact generated by fund restrictions; little knowledge about New Retail; make little efforts to improve employees' learning and innovation ability.*

Keywords-- Inventory management; New Retail; AHP; inventory optimization

1. INTRODUCTION

Since pure play e-commerce companies cannot provide good experience service for customers, their competitiveness has begun to show a declining trend, and the whole industry is seeing a slow growth speed. Pure play e-commerce companies like Vipshop, Jingdong and NetEase Strict Selection have all opened experience stores, which increases pressure on brick and mortar stores. For this reason, large brick and mortar retailers begin to launch their e-commerce platforms. Then the concept of "New Retail" appears. It combines on-line with off-line activities, personnel, goods, warehouse with distribution, and physical retail with e-commerce, creating a more efficient new retail mode. At the same time, small and medium-sized physical stores begin to introduce e-commerce mode like large brick and mortar retailers. However, due to their limited capability and supply of resources as well as the shortage of experience in e-commerce industry, they only advertise their commodities online so as to improve their off-line sales. Furthermore, their off-line sales have little relevance to on-line sales. This will inevitably result in a low sales efficiency, thus increasing the pressure on inventory management.

2. LITERATURE REVIEW

As an important part of company management, inventory management has received attention from many scholars. Many SMEs are still using the traditional inventory management mode which mainly relies on manual work. This largely reduces the efficiency of corporate inventory management, and may give rise to many inventory management problems, which is not beneficial for the long-term development of the company^[1] (Jiang Feng, 2019). Generally, companies solve inventory management problems by properly reducing inventories, decreasing occupation of funds and avoiding shortage or overstock of materials so as to ensure smooth business activities^[2] (Yu Ping, 2019). However, with the emergence of the concept "New Retail", traditional methods are far from enough to solve the inventory management problems faced by SMEs. They should also consider current background of New Retail. Therefore, based on their own business characteristics^[3] (Tong Yingcong, 2017), companies should keep pace with the times in terms of management, and keep improving economic benefit and management level through management innovation and advanced management concept^[4] (Du Tong, 2018). In respect of employee allocation for inventory management, companies should consider employing professionals who have abundant experience in management. They should also establish an inventory performance evaluation mechanism, improve storage worker system, have fixed posts and defined personnel quota, and specify employees' duties and authorities^[5] (Zhou Zhihui, 2019). Braulio Brunaud et al. expanded the traditional supply chain planning model and optimized inventory strategies^[6](2019). In order to optimize both spare parts inventory and service personnel, S. Rahimi-Ghahroodia et al. presented a greedy heuristic method, which can effectively produce a nearly optimal

result^[7] (2019). Zahra Azadia et al. provided a model to analyze the effect of deterioration rate, inventory holding cost and service level on inventory replenishment decisions and retailers' profits^[8] (2018).

In summary, scholars have studied the optimization of inventory management from different perspectives. As the concept of "New Retail" has been proposed, companies have to optimize their inventory management based on the background of New Retail. **In order to** explore the new inventory management problems of small and medium-sized retailers in the context of New Retail, this paper takes ASY company as an example, and analyzes the weights of factors affecting ASY company's inventory management before and after New Retail appears by using the AHP method. The purpose is to study its existing problems, and put forward optimization measures based on its own situation.

3. RESEARCH METHOD

AHP is a decision-making method. It decomposes the correlation factors associated with the decision-making process into subfactors at different hierarchies, analyzes their relevant degree of influence, and then conducts qualitative analysis and quantitative coupling analysis with mathematical tools according to these influences^[9] (Li Ling, 2019). AHP method is applicable to the decision-making problems that have a target system for hierarchical interlaced evaluation indicators and target values which are difficult to make quantitative description^[10] (Luo Xue, Tan Li, 2017). For the factors affecting inventory management of ASY company mentioned herein, their indicators are hard to quantify or make quantitative description, such as the personnel-related indicators that are very uncertain and subjective. Hence, only fuzzy quantization approaches can be used for preliminary identification so as to ensure a smooth process of calculation.

4. RESEARCH FINDINGS

4.1 Company profile

ASY is the largest chain store specialized in selling mother and baby products and providing related service in Hebei, China. Since its establishment on August 28, 2013, it has had more than 300 brick and mortar stores distributed over many cities, including Shijiazhuang, Xingtai, Handan, Baoding, Cangzhou, and Chengde, with the sales growth rate exceeding 50% for three consecutive years. With a strict supply chain purchasing system and a high requirement for quality, ASY tries to provide customers with safe products in a timely manner. This has won it recognition of many companies, such as Yili, Junlebao, Cofco Mengniu, Heng'an Group, and Daddy's Choice. In order to provide better service for its customers, in addition to previous business items like swimming, bathing, and massage, ASY launched postpartum care, confinement sweating, breast care, and pediatric massage in 2017. Its professional service team which comprises more than 30 nutritionists and over 20 nursery teachers can provide one-to-one child rearing as well as prenatal and pregnancy service via micro class. In 2017, ASY offered more than 1,000 classes for mothers, and assessed health conditions of babies for nearly 1000 times. It is the strict quality management and good customer service that help ASY achieve rapid development. Over the past year, ASY opened more than 30 new stores and rebuilt more than 20 stores, realizing its development and expansion. At the same time, it established an angel fund to help the children in need.

4.2 Current inventory management problems

At the beginning, with a few types of products and a simple personnel structure, ASY can manage its inventories using a few resources without a hitch. However, as it keeps growing, inventory management becomes increasingly complicated. Besides, with the rapid development of e-commerce industry, this company which mainly conducts off-line activities tends to be very passive. For example, sales of its baby clothes and products begin to decline so that overstock appears, which increases the inventory management pressure and cost. Due to the overstock of goods, there is no space to store new commodities, so their sales performance will be affected. And the overstocked goods occupy a large amount of funds if they cannot be timely sold. In this context, the cash flow difficulty results in a vicious circle for the company.

4.3 Factors affecting inventory management

There are many factors causing ASY's existing inventory management problems. For inventory management, the following factors needs to be considered:

(1) Management system. In terms of inventory management, a system in relation to inventory management can make inventory management standardized and under control. Besides, it is able to simplify the operating process and improve the efficiency of dealing with affairs. The important systems related to inventory management in ASY include inventory management system, delivery management system, performance evaluation management system, personnel management

system, and incentive management system.

(2) Product categories. As a chain store which provides mother & baby products, ASY has the following products; infant milk powder, FMCG, toys, knitwear, and gifts.

(3) Delivery method. In the past, ASY allowed the headquarters to distribute goods. Now it also requests the manufacturer to deliver its products.

(4) Resource limitation. ASY is mainly limited by the following inventory management-related resources: working site, funds, demand, number of employees, and season.

(5) Sales model. Customers buy ASY products in physical stores. Thus, most of the inventories are prepared for off-line sales. Its on-line sales channels include Moments in WeChat and videos in Kwai. Supplementary to off-line sales, these sales methods have little impact on inventory management. Now New Retail combines on-line and off-line sales, and integrates logistics, service and sales process, producing a significant influence on inventory management.

(6) Personnel capabilities. Employees' capabilities of processing inventory affairs are closely related to inventory management. The important factors of inventory-related personnel include knowledge and skills, communication and coordination ability, executive capability, learning and innovation ability.

4.4 Determination of weights of influencing factors

1. AHP model and its application

(1) Build a hierarchical structure model for factors affecting inventory management

Inventory management problems are caused by many factors. Some factors cannot be measured with quantitative method, which makes the company's prediction of these factors during the process problem analysis become very uncertain. Therefore, this paper employs fuzzy quantization to make quantitative analysis on the influencing factors, calculate their weights, and then rank them to identify their importance. First of all, the inventory management problems are reified and stratified to build a hierarchical matrix model. According to the actual situation introduced by the staff from ASY, we built a hierarchical structure model for the factors affecting inventory management of ASY, as shown in Figure 1.

Its indicator system has three levels:

- The first one is target level, i.e. the company's inventory management problems in this study;
- The second one is criterion level, i.e. classification of influencing factors: management system, personnel capacity, sales model, delivery method, product requirements, and resource limitation.
- The third one is sub-criterion level, i.e. detailed description of the influencing factors at the second level, the purpose of which is to enable the decision makers to know these factors.

Their relationship is as follows: factors at the same level make up those at the upper level and comprise those at the lower level.

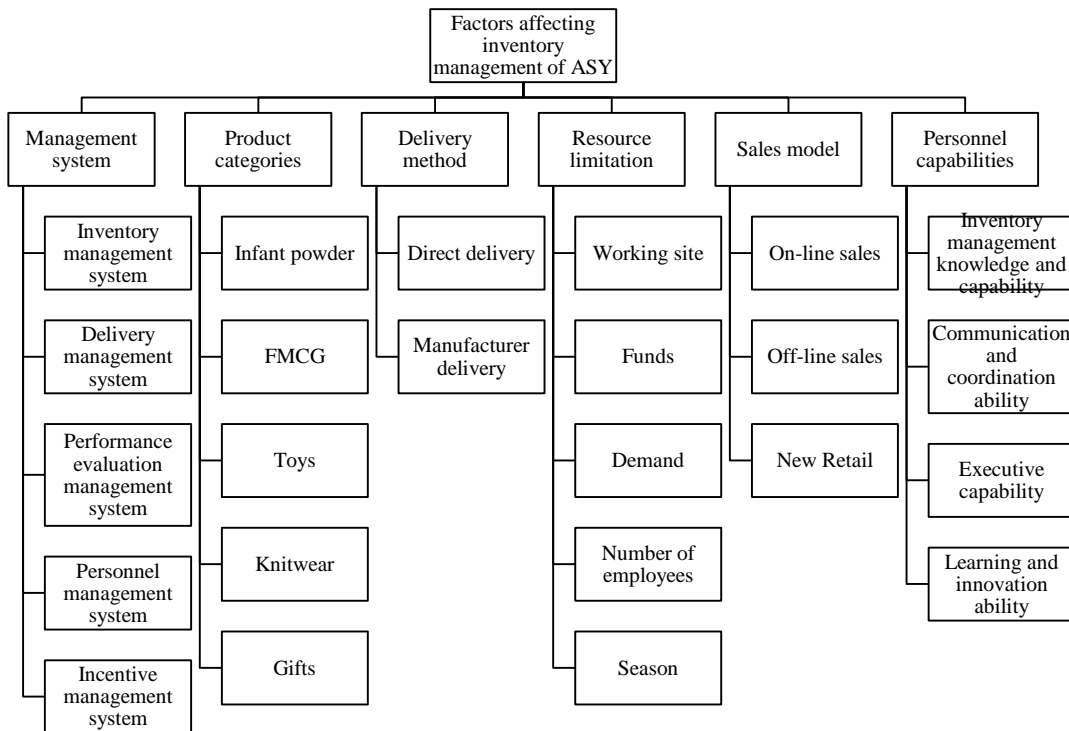


Figure 1 Hierarchical Structure Model for Factors Affecting Inventory Management of ASY

(2) Build judgment matrix for factors affecting inventory management of the company

On the basis of the hierarchical structure model for factors affecting inventory management of ASY, an AHP indicator judgment matrix related to its influencing factors was built. Thirty employees from different departments compared any two indicators, determined their degree of influence based on their experience, and then built a judgment matrix for calculation.

Firstly, the judgment matrix table is built according to the hierarchical structure model for factors affecting inventory management for relevant personnel to fill in. After the qualitative indicators are converted to figures that can be calculated, relevant data will be obtained for calculation and comparison so as to determine the weight of each indicator.

From the second level of the hierarchical structure model, comparison is made between any two indicators at the second level to build a judgment matrix table, and then any two of the indicators subordinate to the same indicator in the third level are compared to build a judgment matrix table. Assume the indicator in the second level is A_i . The indicators in the second level are arranged in the first row and first column of the table. In particular, a_{ij} means the relative degree of influence of A_i over A_j , as shown in Table 1. The indicator subordinate to the same indicator in the third level is determined as B. If the first indicator in the third level is the inventory management system B_1 , then the judgment matrix table has the same format as Table 1.

Table 1 Indicator Judgment Matrix Table

A	A_1	A_2	A_3	A_4	A_5	A_6
A_1	a_{11}	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}
A_2	a_{21}	a_{22}	a_{23}	a_{24}	a_{25}	a_{26}
A_3	a_{31}	a_{32}	a_{33}	a_{34}	a_{35}	a_{36}
A_4	a_{41}	a_{42}	a_{43}	a_{44}	a_{45}	a_{46}
A_5	a_{51}	a_{52}	a_{53}	a_{54}	a_{55}	a_{56}
A_6	a_{61}	a_{62}	a_{63}	a_{64}	a_{65}	a_{66}

Secondly, this paper uses 1~9 ratio scale as the basis for experts to fill in the scale of importance a_{ij} . 1, 3, 5, 7 and 9 are required to indicate the relative degree of influence of one indicator over the other based on experience: equal influence, slight influence, obvious influence, strong influence and extreme influence; 2, 4, 6 and 8 represent the medium value of the two adjacent judgment levels mentioned above, as shown in Table 2. The matrix composed of a_{ij} is judgment matrix.

Table 2 Judgment Matrix Values and Their Meanings

Scale	Meaning
1	The two factors have equal influence.
3	For the two factors, the former is a little more influential than the latter.
5	For the two factors, the former is more influential than the latter.
7	For the two factors, the former is much more influential than the latter.
9	For the two factors, the former is significantly more influential than the latter.
2, 4, 6, 8	Medium value of adjacent judgments, and the influence between factors is within the above description.
Reciprocals of the above figures	One factor is less influential than the other, as described above.

Note: The "former" means the indicators in the column of the judgment matrix, while the "latter" means those in the row of the judgment matrix.

Thirdly, they should visit ASY stores and tell the staff therein their intention, how to fill in the table and the meanings of scale. Then, they need to ask the staff to complete the table based on their own experience prior to collection and sorting them out. This will help them get first-hand data so as to ensure the reliability and authenticity of the information. At last, according to the structure model for factors affecting inventory management, and based on the data and information collected, a judgment matrix is built.

(3) Calculate weights of indicators

Single hierarchical arrangement (weight vector) means the relative weight of each factor in each judgment matrix to its criterion (upper level). Essentially, it aims to calculate the maximum characteristic root of the judgment matrix. The maximum characteristic root is calculated using the square root method. The solving steps are as follows:

1) Calculate the product of elements in each row of the judgment matrix A M_i :

$$M_i = \prod_{j=1}^n a_{ij}, \quad (i = 1, 2, \dots, n; j = 1, 2, \dots, n) \quad (1)$$

2) Calculate the nth root w_i of the product M_i :

$$\bar{w}_i = \sqrt[n]{M_i} \quad (2)$$

3) Normalize \bar{w}_i to obtain w_i :

$$w_i = \frac{\bar{w}_i}{\sum_{i=1}^n \bar{w}_i} \quad (3)$$

Then, $W = (w_1, w_2, \dots, w_n)^T$ is the approximate value of the eigenvector of A . w_i is the weight of indicator B . The data in each judgment matrix and calculated weights are obtained.

(4) Consistency check

The calculation procedures of consistency check are as follows:

1) Calculate the maximum eigenvalue γ_{max} of corresponding eigenvector W :

$$\gamma_{max} = \frac{1}{n} \sum_i \frac{(AW)_i}{w_i} \quad (4)$$

2) Calculate the indicator which measures the degree of inconsistency of the judgment matrix A CI:

$$CI = \frac{\gamma_{max} - n}{n - 1} \quad (5)$$

3) Calculate the random consistency ratio of the judgment matrix A CR:

$$CR = \frac{CI}{RI} \quad (6)$$

Of which, RI refers to the average random consistency indicator, which is related to the matrix order n only. It takes the values in Table 3.

Table 3 Table for Values of Random Consistency Indicator

n	1	2	3	4	5	6
RI	0	0	0.58	0.90	1.12	1.24

When $CR < 0.1$, the judgment matrix A has satisfactory consistency, or the degree of inconsistency is acceptable; otherwise, adjustment and paired comparison should be conducted for matrix A until its consistency is satisfactory. The consistency ratio of each judgment matrix CR is as follows: 0.0995, 0.0883, 0.0854, 0.0176, 0, 0.0823, 0.0944; 0.0612, 0.0349, 0.0082, 0.0279, 0, 0.0935, 0.0918, all < 0.1 . This means all judgment matrices have satisfactory consistency.

(5) Weight analysis

Calculate each judgment matrix with yaahp software, and then summarize the data obtained to draw the following line chart:

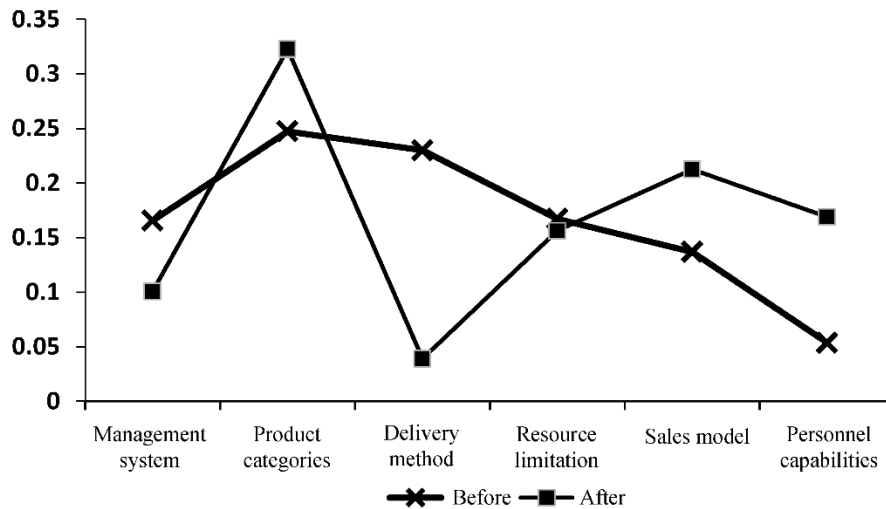


Figure 2 Comparison of Weight of Influencing Factors Before and After New Retail

As shown in the figure, after the New Retail appears, the weight of delivery method shows an obvious decline; product categories, sales model and personnel capabilities experience a sharp rise in terms of weight; resource limitation has little change; the weight of management system slightly decreases. This indicates that New Retail model has changed the company's attention on the factors affecting inventory management. More emphasis is being placed on product categories, sales model and personnel capabilities, and less stress has been laid on management system and delivery method.

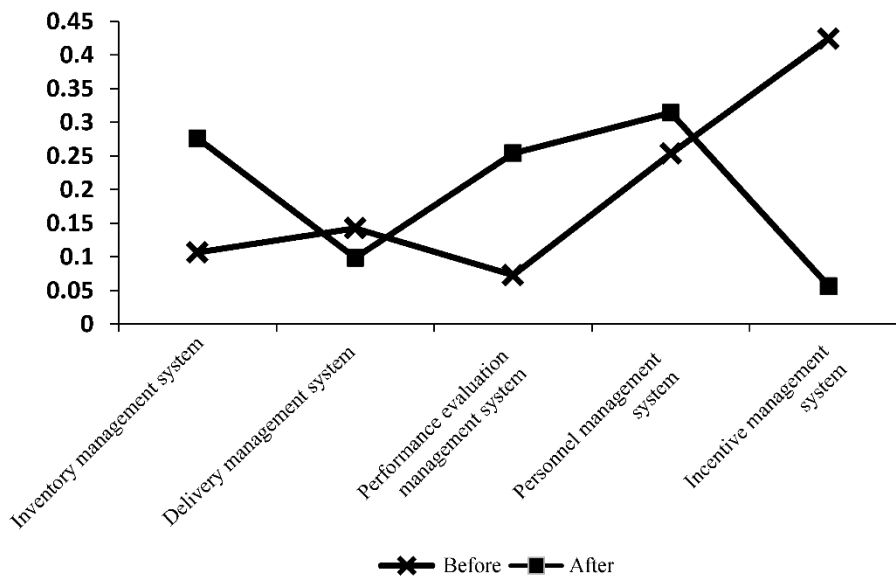


Figure 2 Comparison of Weight of Management System Before and After New Retail

It can be seen from the figure that after the New Retail model appears, both inventory management system and performance evaluation system have much more weights; the weight of personnel management shows a slight rise compared to that before New Retail emerges; delivery management system declines in terms of weight; the weight of incentive management system significantly decreases. This means that after New Retail appears, the company begins to focus on standardizing basic systems, including inventory management system, performance evaluation system and personnel management system. It pays less attention to delivery management system and incentive management system.

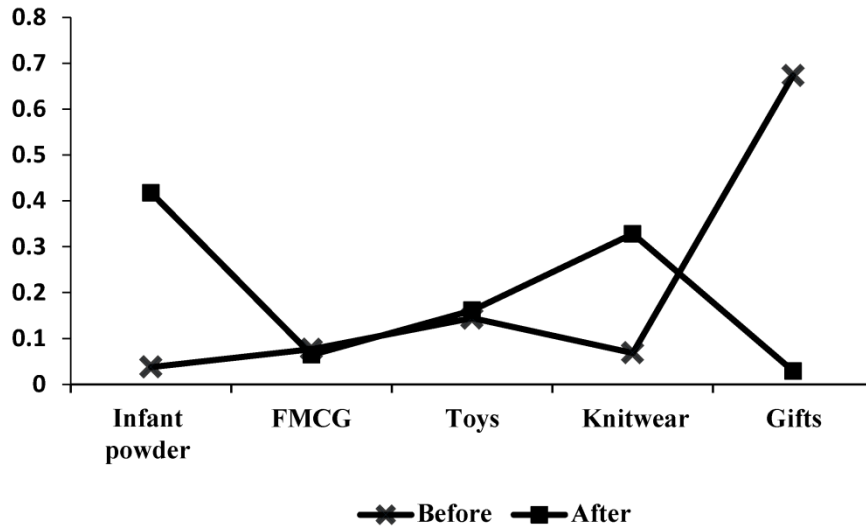


Figure 3 Comparison of Weight of Product Categories Before and After New Retail

The figure shows that with the emergence of New Retail, infant powder and knitwear show much more weights; FMCG and toys have little change in weight; the weight of gifts decreases to a very small number. This indicates that after New Retail appears, the company pays much more attention to its main products, a lot less attention to gifts, and almost the same attention to FMCG and toys.

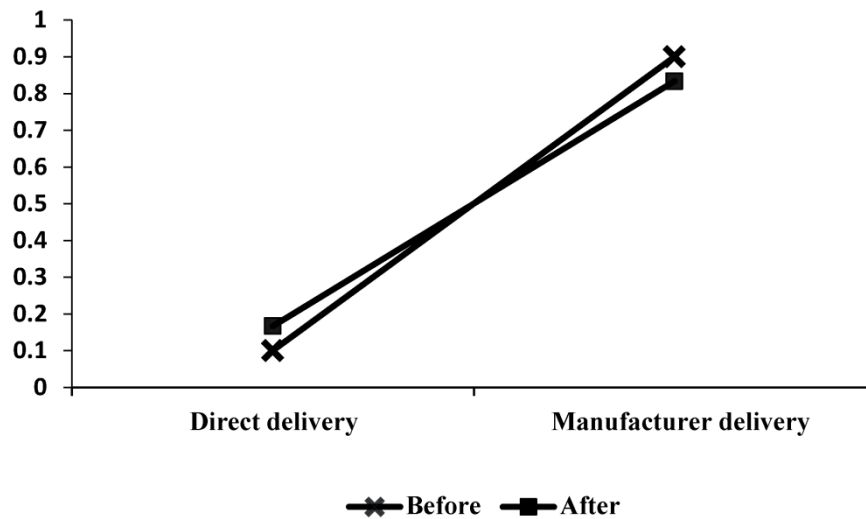


Figure 4 Comparison of Weight of Delivery Method Before and After New Retail

We can see from the figure that after New Retail emerges, the weight of direct delivery shows a little increase, while manufacturer delivery experiences some decrease in weight. Yet as a whole, manufacturer delivery accounts for a very large percentage in delivery method, while direct delivery has a quite small ratio. This means that in respect of delivery method, the percentages of the company's direct delivery and manufacturer delivery tend to be equal, and third-party delivery has not been found.

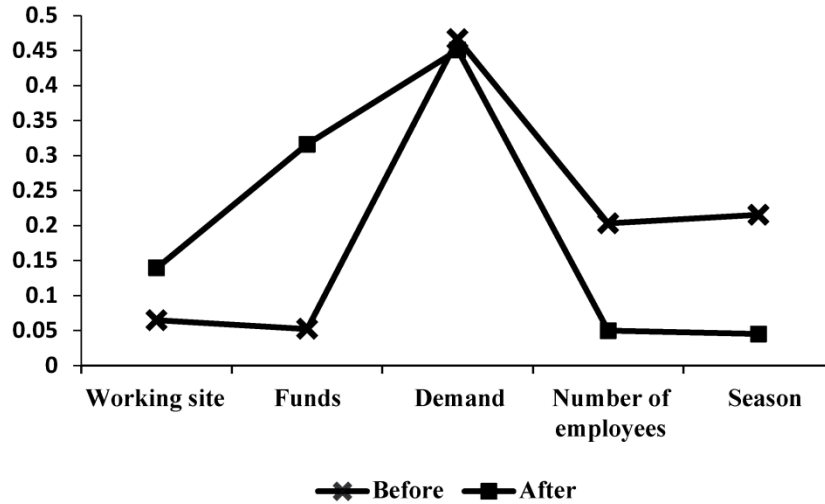


Figure 5 Comparison of Weight of Resource Limitation Before and After New Retail

The figure shows that after New Retail appears, funds account for a much larger proportion, and the weight of working site shows a slight increase. In spite that demand decreases in weight, it still accounts for a large proportion. Both number of employees and season have decreased to a very small proportion. This means that New Retail has little influence on demand, though the requirements for working site and funds become higher. The effect of number of employees and season on inventory management of the company experiences a little decline.

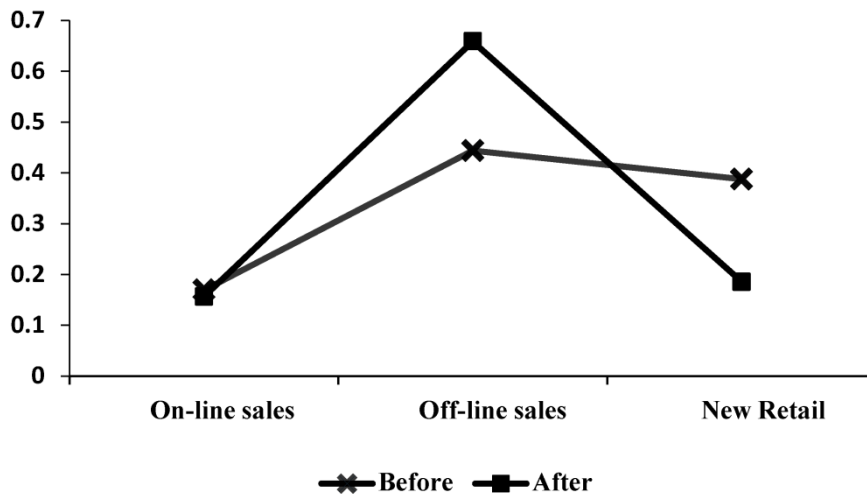


Figure 6 Comparison of Weight of Sales Model Before and After New Retail

It can be seen from the figure that after New Retail shows up, for the weight of each part, off-line sales sharply rise, on-line sales keep unchanged, and the sales model of New Retail has a significant decrease. This indicates that the company pays more attention to off-line sales, almost the same attention to on-line sales, and less attention to the New Retail model after its emergence.

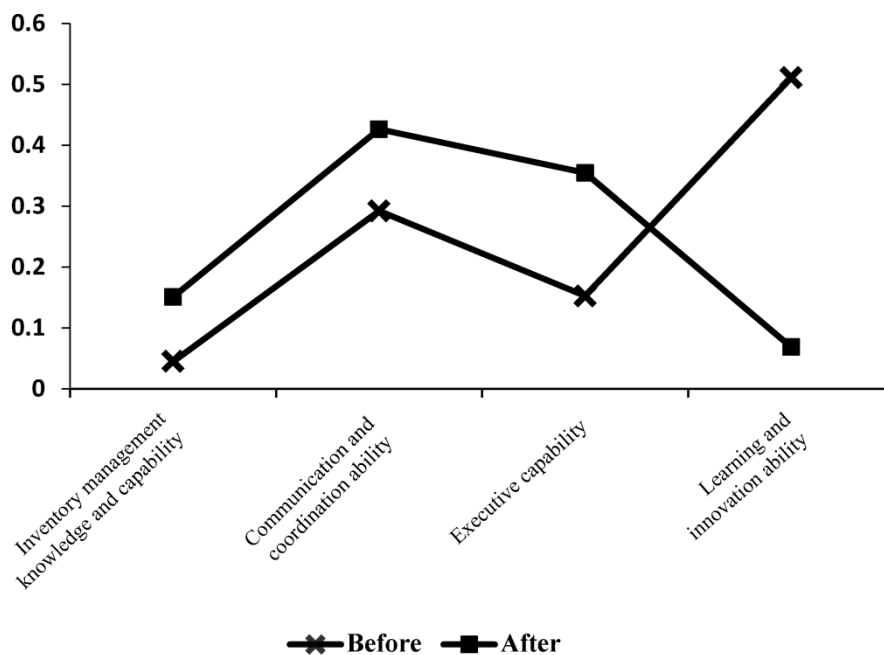


Figure 7 Comparison of Weight of Personnel Capabilities Before and After New Retail

The figure reveals that after New Retail appears, the weights of some personnel capabilities rise a little, including inventory management knowledge and capability, communication and coordination ability, and executive capability; the learning and innovation ability suffers a sharp decline in weight. This means that the company presents more requirements for inventory management knowledge and capability, communication and coordination ability, and executive capability, yet less requirements for employees' learning and innovation ability.

5. DISCUSSION AND COUNTERMEASURES

5.1 Inventory management problems in the context of New Retail

(1) **Inadequate stress on delivery method and management system.** After New Retail is born, the company begins to consider the importance of sale model, product categories and personnel capabilities, yet ignores the role of delivery method and management system in inventory management. Management system is established to standardize the process of inventory management. Delivery method connects manufacturers and warehouses in the process of inventory management. Once the company ignores the role of delivery method and management system, the inventory management system will become weak and cause a lot of loss if any problem arises.

(2) **Poor performance in personnel incentive.** After the concept of "New Retail" is put forward, the company introduces some systems to streamline the process of operation and downsizes its staff, which in turn leads to a slackening of its incentive system for employees. Reduction of the number of employees results in poor performance in daily work. Therefore, the company should put emphasis on the incentive management system for employees.

(3) **Inadequate stress on FMCG.** With the emergence of New Retail, the company's ratios of main products including infant powder and knitwear begin to increase, yet those of FMCG and toys keep unchanged, so that the inventory management department pays less attention to FMCG and toys. Customer experience is very important for FMCG and toys. Nonetheless, as the company lays insufficient stress on them in inventory management, their circulation in inventory management and thus customer experience are affected.

(4) **Heavy workload resulted from manufacturer delivery.** ASY stores delivery goods via manufacturers, i.e. after the headquarters places orders, manufacturers deliver the goods. Without management by the headquarters, staff in each store are required to directly manage inventories. In this case, the system is operated by multiple persons, which will increase information errors and thus affect inventory management level.

(5) **Increased influence from limitation of funds.** After New Retail appears, the company's inventory management is largely influenced by funds. The New Retail model needs to be supported by some systems, which means the company will be limited by funds.

(6) **Little knowledge about the New Retail model.** The company has paid inadequate attention to the New Retail model in inventory management. As this model keeps moving forward, the company doesn't show an optimistic

attitude towards it. It just stressed the importance of off-line sales instead of exploring the sales model of New Retail.

(7) **Less stress on employees' learning and innovation ability.** In order to streamline some processes of operation, the company introduces corresponding systems and stops improving employees' learning and innovation ability, which is unfavorable to the development of its inventory management.

5.2 Optimization strategies based on data analysis

(1) **Lay emphasis on management system and delivery method.** The company needs to propose standards and measures for inventory management system, and take delivery method seriously. Besides, equal attention should also be paid to sales model. In the context of New Retail, the company needs to coordinate the relationship in different aspects, and prepare contingency plans to prevent emergencies from occurring and guarantee its stable operation.

(2) **Lay emphasis on incentive management system.** The company needs to formulate some incentive management systems and give material rewards or moral encouragement once employees' work performance meets certain requirements, such as promotion, welfare, and job title. In addition, relevant department should strictly perform performance evaluation and reward, which should be open and transparent, without any dispute.

(3) **Lay stress on FMCG and toys.** While focusing on the operation of FMCG and toys, it should pay attention to customer experience. Best experience will enable customers to buy more commodities and accelerate their circulation so as to improve the inventory management level.

(4) **Resort to third-party logistics.** The company may reach an agreement with the manufacturers on the following process: based on customers' demand, the company places orders with the manufacturers which then delivery the products to customers via third-party logistics. This will reduce some inventories as well as the inventory management work.

(5) **Reduce the influence of limitation of funds on inventory management.** In the context of New Retail, the company introduces several systems to streamline some processes of operation, in which case, the limitation of funds has a large influence on inventory management. The company may reduce such influence by cutting down the costs on storage and maintenance of goods. The company may negotiate with the manufactures and allow them to directly deliver some goods to customers without storing them in the store. This will reduce the costs on delivery, storage and maintenance, and thus the influence of funds on inventory management.

(6) **Promote the integration of on-line and off-line sales.** Characterized by convenience and rapidness, pure play e-commerce companies have seen a fast development in recent years, which poses a great impact on the sales of brick and mortar stores. In spite of this, these companies can never provide off-line experience, which means the era of pure play e-commerce will come to an end. The company should adopt the "New Retail" model, and focus on combining off-line sales with on-line sales. In this case, it can provide both off-line experience and convenient and fast delivery service while improving the operating speed of inventory management.

(7) **Focus on improving employees' learning and innovation ability.** In order to ensure that relevant inventory management staff have abundant knowledge and skills, the company needs to organize learning and training activities on a regular basis. The employee with outstanding performance may be assigned to serve as the trainer. This can not only recognize his contributions to the company, but also save some training costs for the company.

6. CONCLUSION

By taking ASY company as an example, this paper studies the effect of New Retail model on the inventory management of small and medium-sized retailers. There are six influencing factors, i.e. management system, personnel capabilities, delivery method, sales model, product categories, and resource limitation. For the influence of New Retail model on the inventory management of the company, it proposes some optimization measures. On the whole, the development of New Retail is very competitive. Thus, companies should explore New Retail model so as to lay a solid foundation for their sound development. With limited information, we only provide optimization strategies based on the investigation data. The research on effect evaluation is inadequate. In future studies, we hope to build an inventory management system which is consistent with the New Retail model for small and medium-sized retailers to promote the steady development of these companies.

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