Research Journal of Finance and Accounting
ISSN 2222-1697 (Paper) ISSN 2222-2847 (Online)
Vol.7, No.8, 2016

Optimization on FMCG Distribution Based on the Cross-Docking Mode: Taking a Cooperative Project as an Example

Xinxin Meng*
Management School, Jinan University,601 Huangpu Avenue West, Guangzhou 510632, China

Abstract
Cross-docking, as a new breakthrough for enhancing the distribution center's operation efficiency and reducing inventory level, has accelerated the product circulation. Distribution, as an important part of logistics service, directly influents customers' satisfaction. According to FMCG (Fast Moving Consumer Goods) distribution, high warehouse cost affects the profitability of the company in a way. So, reducing logistics cost and increasing efficiency has become a pivotal focus. This paper focuses on problems such as high warehouse cost and low operation efficiency in project RDC that found in a cooperative project from Company A (a third party logistic enterprise) and Company B (FMCG company). Concerning the characteristics of FMCG distribution, this paper highlights a strategy that traditional distribution mode should be substituted by adopting the cross-docking mode, and that the model of the comprehensive evaluation index system (AHP-TOPSIS) should be built in order to verify our idea. A series of supporting measures should be also presented based on the discussion and analysis of mode and data, which gives recommendations on selecting a supreme logistics mode for Company A, and then achieve a more efficient operation for distribution centers. Meanwhile researching FMCG distribution from the perspective of cross-docking mode is an innovation. Our research considers a certain theoretical and practical significance to enhance the overall operating ability of the Third Party Logistics enterprises and shorten the cycle of the supply chain.
Keywords: FMCG; Cross-docking mode; logistics pattern; Optimization

0 Introduction

In the recent few years, FMCG distribution has been attracted much attention in China. However, there are many characteristics such as short shelf life, fast-consumption and low contribution margins (Ullah and Shafayet, 2012). Thus, a higher level of efficiency and cost control are demanded of the FMCG logistics (Brockmann, 1999). A typical example of the FMCG distribution in China is the cooperative project of the Company A and Company B. In the face of fierce market competition, Company A, a third party logistic enterprise (TPL enterprise), must attach great importance of optimizing distribution pattern and constantly improve the distribution efficiency. Cross-docking mode can meet the object requirements of the logistic development in China. It not only provides lower cost of distribution, inventory and handling but also yields other advantages, such as reduction in the space and quantity of the warehouse on supply chain, decrease the damage rate of goods while increase the utilization rate of the distribution centers, as well as integrate orders to improve the customer service level, which conforms to the demand for logistics distribution in our country. Therefore, the optimization study on FMCG distribution based on cross-docking is with theoretical and practical significance.

Many researches from domestic and foreign scholars focus on certain aspects of cross-docking, such as effect and significance (Schaffer,1997; Apte and Viswanathan,2000; Bartholdi and Gue,2000; John Joseph Vogt,2010), process and distribution range(Lee and Jung,2006; Ma and Miao and Lim ,2011), mode and algorithm (Cheng andWang,1998; Chen and Lee,2005; Chen Feng and Song Kailei,2006;Shi Wen and LIU Zhixue and LIU Dan,2013; MIAO Zhaowei, YANG Feng and XU Dongsheng and SHI Ning,2011, etc.). Based on the cross-docking mode and the theoretical models, some of the researchers investigated the optimization of the process in certain distribution centers but also lacking for the guiding significance in practical use (Gumus and Bookbinder, 2004; Ramanathan, 2007). Thus, attention should be paid to investigating the actual operation and practical analysis of specific industry and enterprise respectively. In this paper, we mainly investigate the FMCG distribution mode of the project cooperated between Company A and Company B in Guangzhou, and organically combine AHP and TOPSIS methods, which can be implemented to assess the optimization of selecting distribution mode. The combined method overcomes the subjectivity of AHP in indices that are not easily quantified as well as avoids the ignorance of index weight in TOPSIS. Finally, to ensure the fine operation of the optimized mode, this study puts forward safeguard measures in cross-docking mode.

1. General situation in delivery and problem analysis

1.1 Introduce Company A and Company B project

In this cooperative project, Company A provides logistic services including the warehousing and storage, transportation, distribution, packaging and so on. To meet the customer's demands of orders, Company B replenish the project RDC from factories (a, b, c, d, e, f, g), CDC (a', b', c', d', e') and other RDC (a'', b'', c'', d'', et al.), in view of their inventories. This forces the project RDC to increase its inventory, which takes up unnecessary capital and warehouses. Moreover, as the project RDC absorbs the inventories from Company B and the customers, Company A will face a higher inventory risk. Figure 1 illustrates the process of the project cooperated between Company A and Company B.

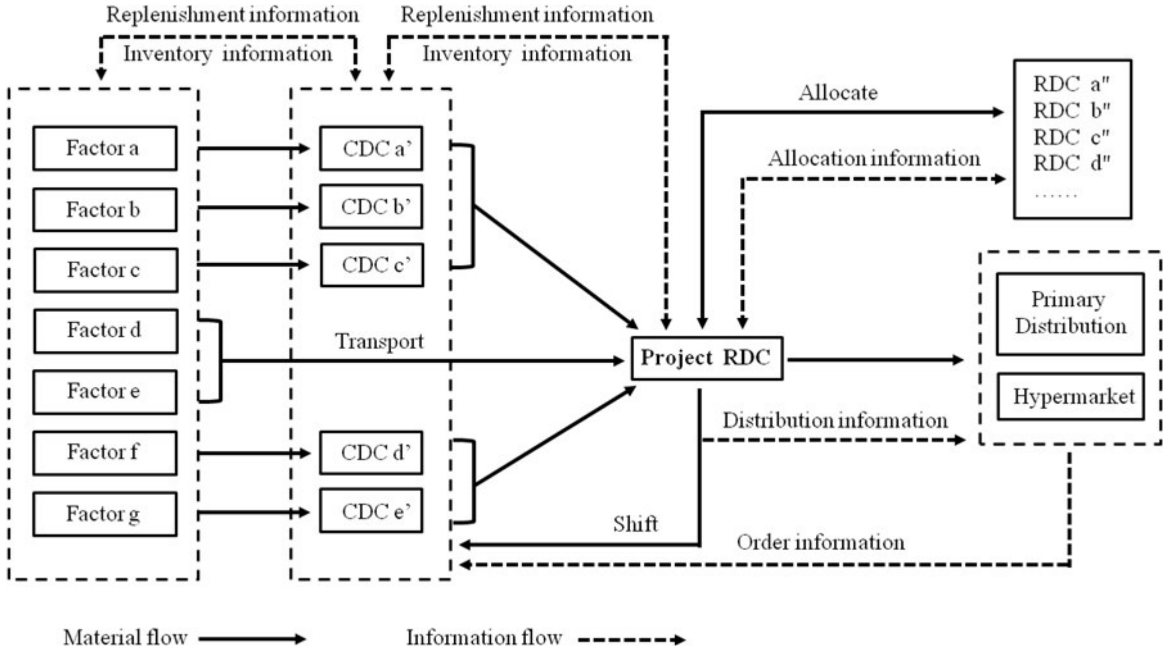

Figure 1. Process of the project cooperated between Company A and Company B

1.2 Problems with traditional distribution mode

1.2.1 High warehouse cost

The warehouse area of project RDC is around 33,000m2, bringing a high cost of warehouse and a low efficiency in capital turn over.

1.2.2 Serious inventory loss

The inventory loss mainly comes from cargo being destroyed, being reported as useless, being lost, rotten, etc. Loading and unloading frequently bring damage to goods. Besides, volatility of the market is a potential cause for depreciation and expiration while the goods are heaped up in the project RDC.

1.2.3 High work intensity of operating personnel

Stock keeping unit (SKU) of FMCG is very large. So is the pallets, which lead to the increasing work loads for the operating personnel. Plus with the handling, manpower cost are under great pressure.

1.2.4 Low rate of order integration

Most of the transportation service of Company A is outsourced, which makes it difficult to form a close cooperation between different projects in distribution. Common carrier will transport goods back to the distribution centre if the vehicle is not in complete wagon loan. This results in the low rate of order integration and most probably, influence the timeliness and the customer's satisfaction.

Obviously, a stronger turnover capacity, a faster distribution speed and a higher distribution quality are demanded in Company A in order to provide a high-efficient, flexible, safe and low-cost logistic service.

2. Formulate cross-docking mode based on FMCG distribution

2.1 Cross-docking mode formulated based on the characteristics of FMCG distribution

The practice has shown that, to promise the maximum efficiency and profit, cross-docking is most suitable in distributing cargos that are with a large demand, stable demand rate, low shortage cost and low shortage risk. In the cooperative project, FMCG is very suitable for the cross-docking mode because of its characteristics such as fast turnover, big batches, stable demand, low single cargo value, and high freshness demand.

2.2 Cross-docking mode formulated based on the demand of FMCG distribution

The prerequisite of adopting cross-docking mode is stabilization of the quantity of the orders. The larger amount of the cargos going in and out, the better effect of reducing inventory the cross-docking brought. In the project, FMCG, mainly food and cosmetics, is nearly stable in the total demand while fluctuating in daily in- and out stock. Therefore, cross-docking mode is preferable in FMCG distribution. This paper statistically analyzes the average order quantity of project RDC in every month from 2013 to 2015. The result indicates that the total order quantity remains stable, as shown in figure 2.

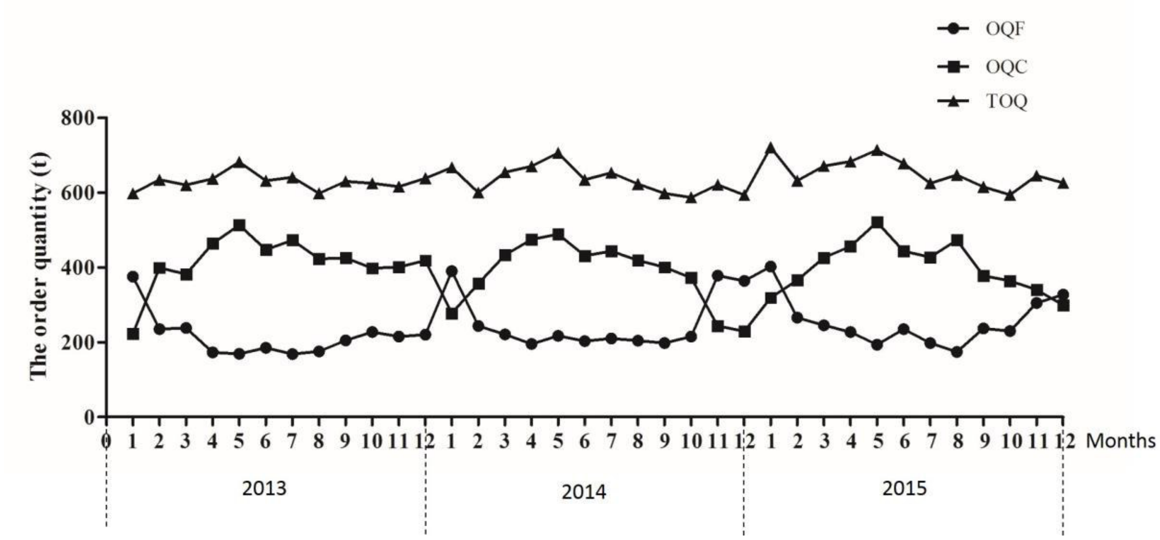

Figure 2. The average order quantity of project RDC in every month (2013-2015)
OQF: order quantity of food; OQC: order quantity of cosmetics; TOQ: total order quantity

2.3 Cross-docking mode formulated based on the cost control

According to the data, the daily out stock quantity of FMCG is around 550T in the project RDC. Taking the continuance of the in-out stock cargos, the project RDC should at least assure the inventory is not less than 1100T. Cargos are all in pick face, which will take up only 4468m2, greatly reduce 29,000m2 of the warehouse area. After applying the cross-docking mode, Company A has saved much more warehouse area per project, thus capable of developing more cooperative projects. Therefore, it becomes one of the channel to increase income and improve economic efficiency.

3. The superiority of the cross-docking based on AHP-TOPSIS

3.1 Introduction of the index system

This paper collects the related data from literatures, investigation and brainstorm, in order to provide a reliable reference to the index system. Based on the distribution mode in the present researches and the realistic operating situation of the project cooperated between Company A and Company B, this paper determines the key index of selecting distribution mode and constructs analytical hierarchy process (AHP) model, shown in Figure 3.

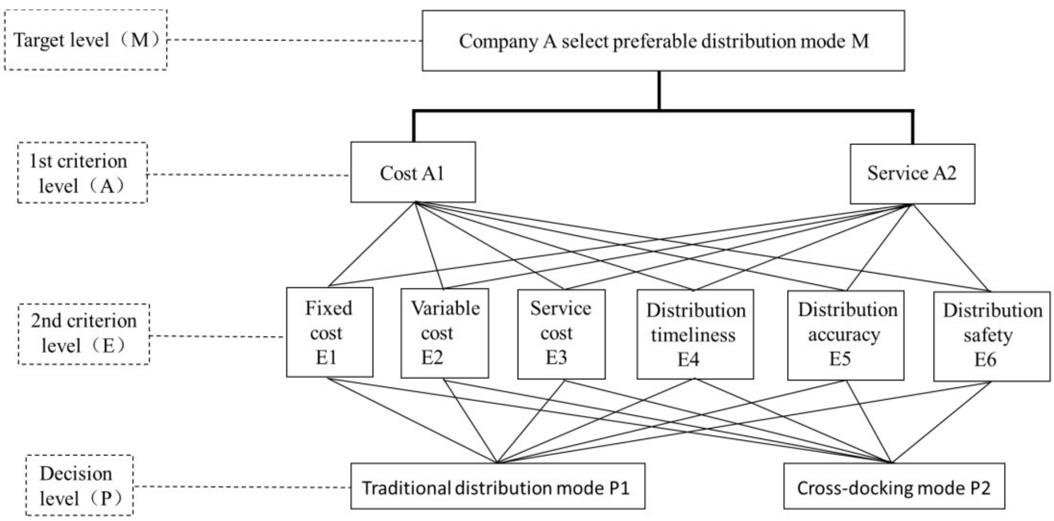

Figure 3. Analytical hierarchy process model

3.2 Determine the index weight

Following the principle of AHP, this paper has concluded the 16 experts' forecasting opinions by "back to back"

Delphi Method. After 3 turns, the data was gathered and presented in the following table 1-10.

3.2.1 Construct the Judgment matrix A-M (first criterion level-target level)

Table 1. Judgment matrix A-M

M	A1	A2	W_M
A1	1	1/3	0.25
A2	3	1	0.75

3.2.2 Construct the Judgment matrix E-A (second criterion level-first criterion level)

Table 2. Judgment matrix E-A1 (second criterion level-cost)

A1	E1	E2	E3	E4	E5	E6	W_{A1}
E1	1	2	3	8	5	7	0.3819
E2	1/2	1	3	7	5	8	0.3006
E3	1/3	1/3	1	5	3	6	0.1671
E4	1/8	1/7	1/5	1	1	2	0.0503
E5	1/5	1/5	1/3	1	1	3	0.0673
E6	1/7	1/8	1/6	1/2	1/3	1	0.0329

Table 3. Judgment matrix E-A2 (second criterion level-service)

A2	E1	E2	E3	E4	E5	E6	W_{A2}
E1	1	2	2	7	3	6	0.3252
E2	1/2	1	2	8	2	7	0.2508
E3	1/2	1/2	1	8	4	8	0.2375
E4	1/7	1/8	1/8	1	1/2	4	0.0533
E5	1/3	1/2	1/4	1/2	1	5	0.1033
E6	1/6	1/7	1/8	1/4	1/5	1	0.300

3.2.3 Construct the Judgment matrix P-E (decision level-second criterion level)

Table 4. Judgment matrix P-E1 (decision level-fixed cost)

E1	P1	P2	W_{B1}
P1	1	4	0.8
P2	1/4	1	0.2

Table 5. Judgment matrix P-E2 (decision level-variable cost)

E2	P1	P2	W_{B2}
P1	1	8	0.8889
P2	1/8	1	0.1111

Table 6. Judgment matrix P-E3 (decision level-service cost)

E3	P1	P2	W_{B3}
P1	1	7	0.8750
P2	1/7	1	0.1250

Table 7. Judgment matrix P-E4 (decision level-distribution timeliness)

E4	P1	P2	WB4
P1	1	1/5	0.1667
P2	5	1	0.8333

Table 8. Judgment matrix P-E5 (decision level-distribution accuracy)

E5	P1	P2	W_{B5}
P1	1	1	0.5
P2	1	1	0.5

Table 9. Judgment matrix P-E6 (decision level-distribution safety)

E6	P1	P2	WB6
P1	1	1/2	0.3333
P2	2	1	0.6667

3.2.4 Hierarchy general ranking and uniformity inspection (table 10)

Table 10. Hierarchy general ranking and uniformity inspection

	λ	CI	CR	consistency check
first criterion level-target level	2	0	0	pass
second criterion level-first criterion level	6.2378	0.0476	0.089	pass
second criterion level-first criterion level	6.5001	0.10002	0.0794	pass
second criterion level-first criterion level	/	0.060705	0.0482	pass
decision level-second criterion level	2	0	0	pass

To reflect the synthetic index system concretely and objectively, this paper presents different index systems by the hierarchy frame (table 11). Hierarchy general ranking weight of every index is shown below in table 12.

Table 11. Index system of each plan

project		Scheme I	Scheme II
1st criterion level	1st criterion level		
A1	E1	33.24	104
	E2	1	8
	E3	1	7
A2	E4	5	1
	E5	1	1
	E6	2	1

Table 12. Hierarchy general ranking weight

E	W_{A1}	W_{A2}	general ranking weight
E1	0.3819		0.292(w_1)
E2	0.3006		0.23 (w_2)
E3	0.1671		0.128(w_3)
E4		0.0533	0.041(w_4)
E5		0.1033	0.079(w_5)
E6		0.3	0.23 (w_6)

3.3 AHP-TOPSIS synthetic judgment about the superiority of the cross-docking mode

3.3.1 Cost index evaluation

(1) Build cost index initial judgment matrix P= $(E_{ij})_{2\times3}$

Assume plan set to be P= {P1, P2} ,index set E= {E_1, E_2, E_3} ,the corresponding evaluation index set E_{ij}(i=1, 2; j=1, 2, 3).In E_{ij}, i means the serial number of the plan while j means the judging index, which is shown in the equation (1).

$$P=(E_{ij})_{2\times3}=\begin{pmatrix} E_{11} & E_{12} & E_{13} \\ E_{21} & E_{22} & E_{23} \end{pmatrix}=\begin{pmatrix} 33.24 & 1 & 1 \\ 104 & 8 & 7 \end{pmatrix} \quad (1)$$

(2) Build standardized decision matrix X= $(x_{ij})_{2\times3}$

E_1, E_2, E_3 are indices that required to be as small as possible. The elemental calculation in X= $(x_{ij})_{2\times3}$ was shown in equation (2) and equation (3).

$$x_{ij} = \frac{\max_j (E_{ij}) - E_{ij}}{\max_j (E_{ij}) - \min_j (E_{ij})} \quad (2)$$

$$X = (x_{ij})_{2\times3} = \begin{pmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \end{pmatrix} \quad (3)$$

(3)Build weighted decision matrix $C = (c_{ij})_{2\times3}$, shown in equation (4).

$$C = (c_{ij})_{2\times3} = \begin{pmatrix} w_1x_{11} & w_2x_{12} & w_3x_{13} \\ w_1x_{21} & w_2x_{22} & w_3x_{23} \end{pmatrix} = \begin{pmatrix} 0.292 & 0.23 & 0.128 \\ 0 & 0 & 0 \end{pmatrix} \quad (4)$$

(4) Calculate the closeness degree of the evaluation objects.
In the cost index, the fixed cost E1, variable cost E2, service cost E3 are all cost indices. The positive ideal solution and negative ideal solution are shown in equation (5).

$$\begin{cases} C^+ = \{ (\max_i c_{ij} \mid j \in J_1), (\min_i c_{ij} \mid j \in J_2) \} = (0, 0, 0) \\ C^- = \{ (\min_i c_{ij} \mid j \in J_1), (\max_i c_{ij} \mid j \in J_2) \} = (0.292, 0.23, 0.128) \end{cases} \quad (5)$$

(5)The distance between the schemes and the positive and negative ideal solution are shown in equation (6) and (7).

$$\begin{cases} d_1^+ = \sqrt{\sum_{j=1}^{3} (c_{ij} - c_j^+)^2} = 0.393 \\ d_1^- = \sqrt{\sum_{j}^{3} (c_{ij} - c_j^-)^2} = 0 \end{cases} \quad (6)$$

$$\begin{cases} d_2^+ = \sqrt{\sum_{j=1}^{3} (c_{ij} - c_j^+)^2} = 0 \\ d_2^- = \sqrt{\sum_{j}^{3} (c_{ij} - c_j^-)^2} = 0.393 \end{cases} \quad (7)$$

(6)The relative closeness of the schemes and the positive ideal solution are shown in equation (8).

$$\begin{cases} F_{11}^+ = 0/0.393 = 0 \\ F_{12}^+ = 0.393/0.393 = 1 \end{cases} \quad (8)$$

3.3.2 Service index evaluation
(1)Similar to the cost index evaluation, in the service index evaluation, the weighted standardized decision matrix $C=(c_{ij})2\times3$ can be calculated in equation (9).

$$C = \begin{pmatrix} 0.041 & 0 & 0.23 \\ 0 & 0 & 0 \end{pmatrix} \quad (9)$$

(2)In the service index, the distribution timeliness, accuracy and safety, which are represented in E4, E5, and E6, respectively, are benefit oriented indices. The positive ideal solution and negative ideal solution are shown in equation (10).

$$\begin{cases} C^+ = (0.041, 0, 0.23) \\ C^- = (0, 0, 0) \end{cases} \quad (10)$$

(3)The distance between the schemes and the positive and negative ideal solution are shown in equation (11) and (12).

$$\begin{cases} d_1^+ = 0 \\ d_1^- = 0.234 \end{cases} \quad (11)$$

$$\begin{cases} d_2^+ = 0.234 \\ d_2^- = 0 \end{cases} \quad (12)$$

(4)The relative closeness of the schemes and the positive ideal solution are shown in equation (13).

$$\begin{cases} F_{21}^+ = 0.234/0.234 = 1 \\ F_{22}^+ = 0/0.234 = 0 \end{cases} \quad (13)$$

3.3.3 Synthetic evaluation of the distribution mode

According to the AHP analysis, the judgment matrix D of target level and the first criterion level and the weighted matrix W was constructed, shown in equation (14) and (15).

$$D = \begin{pmatrix} 1 & 1/3 \\ 3 & 1 \end{pmatrix} \tag{14}$$

$$W = \begin{pmatrix} 0.25 \\ 0.75 \end{pmatrix} \tag{15}$$

Judgment matrix F, which was constructed based on closeness degree of the cost and the service indices, synthetically evaluated the objects, shown in equation (16) and (17).

$$F = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \tag{16}$$

$$Z = W \times F = (0.75, 0.25) \tag{17}$$

In sum, AHP-TOPSIS indicated that the cross-docking mode is better than the transitional distribution mode. Therefore, in this project cooperated between Company A and Company B, the project RDC should adopt the cross-docking mode in distribution.

4. The operating process in cross-docking mode

4.1 The external process of cross-docking mode in FMCG distribution

In this project, the process of cross-docking includes the factories, CDC, project RDC, other RDC and the information and material flows between customers. The customers send their orders to Company B, which include the detailed information (classification, variety, quantity, arriving date, et al.) of the cargo. After integrating the orders, Company B forwards the orders to the factories, CDC and the other RDC by docking system. According to the orders, factories, CDC and other RDC plan for distribution. The shipping information, such as SKU, quantity of the chests, will be send to the project RDC while shipping starts. The Electronic Data Interchange (EDI) docking modules of company B seamlessly docks with the customer ERP system. After the project RDC receives and inspects the cargo, make sure the orders being processed accurately, it gives feedbacks to the factories, CDC and the other RDC. Finally, the project RDC separately loads the cargos, according to their destination, to different vehicles and immediately provides the customers with the shipping information. The process was shown in figure 4.

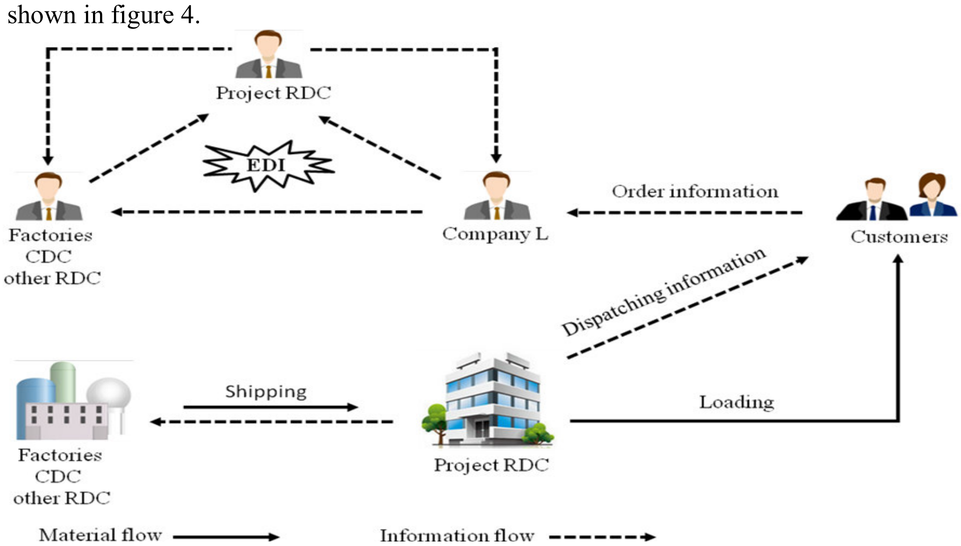

Figure 4. The external process of cross-docking in project RDC

4.2 The internal process of cross-docking mode in FMCG distribution

In cross-docking, the receiving and shipping areas of project RDC are composed of platforms for loading and unloading. When it arrives in the project RDC, the cargo will be unloaded first, followed by the segment of scanning and inspection. After picking, the cargos will be transported to the temporary storing area, which belongs to the shipping area， waiting for loading. When in turn, after confirmation, the cargos will be shipped. The project RDC delivers information includes distribution time, location and status, to the customers. The process was shown in figure 5.

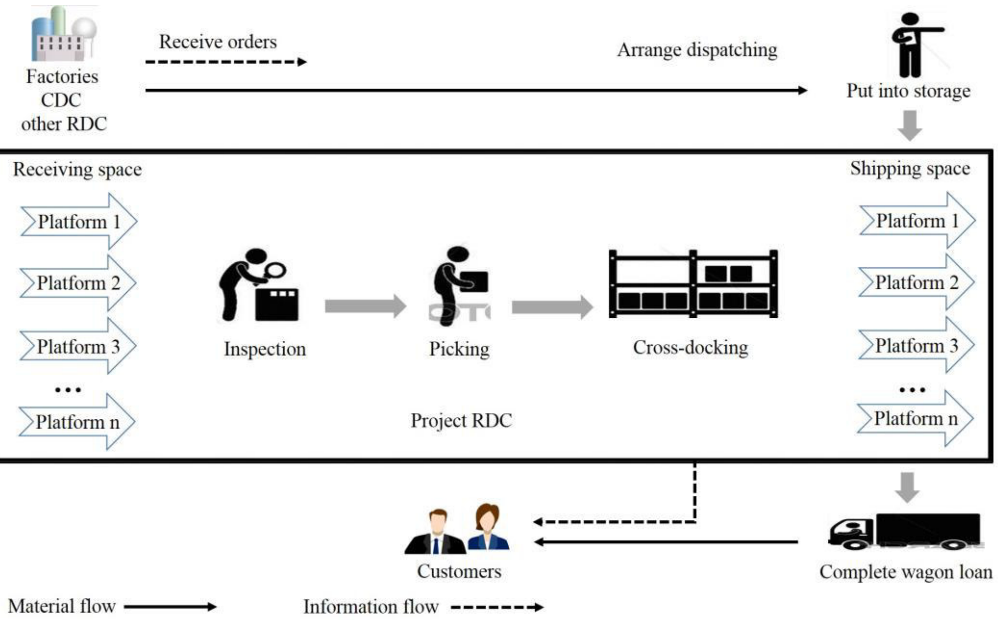

Figure 5. The internal process of cross-docking in project RDC

5. Safeguarding of carrying out cross-docking mode

In operation, the cross-docking mode possesses a high potential efficiency. However, it is complicated in operating, which demands a detailed scheme and an active cooperation.

5.1 Stable market demand

A stable market demand prediction, a high demand and a low shortage cost are three standards in cross-docking mode. These are also the major premises in guarantee that the distribution centre will continue operating efficiently and make more profits.

5.2 Harmonious cooperation between knots of supply chain

In cross-docking mode, to promise the cargo to be accurately distributed, CDC, EDC and customers should highly cooperate and share the information. Hence, strategic partnership should be built and the benefit, cost, risk should be shared reasonably in cross-docking. This is the basic demand in safeguarding the smoothness of cross-docking operation.

5.3 Strict quality control

In cross-docking mode, it is impossible to inspect every single cargo after they arrived. Instead, they will be simply divided in different groups. Therefore, it is factories, CDC and the other projects' duty to control the quality of the cargos in supplement, which can promise the logistic circulation.

5.4 High quality of freighter

After adopting cross-docking mode in project RDC, the freighter should possess a reliable transportation mode, in order to make sure the cargo ship and arrived on time. Only when the freighter offers its full support can the cargo be delivered following exactly the schedule in the system.

5.5 Rapid emergency reaction

Rapid emergency reaction mechanism is one of the most important guarantee for Company A when facing the change of market demand. The quantity of the order of Company B are relatively stable, except in holiday. When the exception comes, Company A can rapidly rent reserve warehouses and recruit operation personnel, reasonably distribute the resources and facilities, in order to keep the logistic circulation.

5.6 High-efficient warehouse management process

Cross-docking mode aims at keeping low inventory while promise a rapid logistic circulation. High-efficient warehouse management regulation plus with KPI performance appraisal are the important conditions for the standardization of the warehouse operation.

6. Conclusion

This paper, based on the project cooperated between Company A and Company B, analyses the enterprise case in reality. Focused on the optimization of the distribution mode, this paper suggests that the cross-docking mode should be adopted for Company A to provide a better logistic service. Moreover, this paper organically combines the AHP and TOPSIS, which were applied in selecting a better distribution mode. AHP is used to weight the indices and AHP-TOPSIS synthetic judgment indices system is based on the sorting method of the closeness to the ideal solution. After comparing the traditional distribution mode with the cross-docking mode, the latter is proved to be better than the former. This paper is mainly carried out in three aspects:

(1) Suggesting cross-docking mode for FMCG.

This study deeply analyzes the present situation and problems of the FMCG distribution mode in the cooperated project of Company A and Company B, and optimized the process from the view of cross-docking distribution. FMCG using cross-docking distribution is a relatively new research.

(2) The superiority of the cross-docking proved by the AHP-TOPSIS.

This study makes an explicit introduction of the in- and external operating process of cross-docking. The AHP-TOPSIS model is used in selecting the distribution mode and proves that the cross-docking is better. The model is the key innovation in this paper

(3) The safeguarding of operating the cross-docking mode.

This study suggests several requirements safeguarding the cross-docking mode against problems. Specific suggestions, one of the focus point of this study, are made aimed at Company A and Company B.

Cross-docking mode makes logistics distribution a real "Third profit source", which accords with the objective need of FMCG distribution in China. In the future, more researches about Cross-docking mode should be concerned in the characteristics of specific industries and goods, then put forward some novel and available strategies in order to increase the practical significance of cross-docking mode.

References

Ullah,G. M. Shafayet(2012).Factors Influencing the Bangladeshi Consumers Purchase Decision Regarding Fast Moving Consumer Goods: An Exploratory Study.*Journal of Brand Management.*, 17(9) , 7-27.

Brockmann T(1999).21 warehousing trends in the 21st century. *IEE Solutions*, 31(7): 36-40.

Gumus M, Bookbinder JH(2004).Cross-docking and its implications in location distribution systems. *Journal of Business Logistics*,25,199-229.

Ramanathan,V(2007).Retailing Channel Enhancement Strategies Adopted by FMCG companies in South Indian Rural Markets.*ICFAI Journal of Management Research.2007*, 6(11),64-70.

Schaffer, B(1997).Implementing a successful cross docking operation. *IIE SOLUTIONS*, 29,34-36.

Uday M. Apte, S. Viswanathan(2000).Effective cross docking for improving distribution efficiencies. *International Journal of Logistics: Research and Applications*, 3(3) ,291－302.

Bartholdi III J J, Gue K.R(2000).Reducing labor costs in an LTL cross docking terminal. *Operations Research*,48(6),823－832.

John Joseph Vogt(2010).The successful cross-dock based supply chain. *Journal of Business Logistics*,31(1),99-119.

Lee Y H, Jung J W, Lee K M(2006).Vehicle routing scheduling for cross-docking in the supply chain. *Computers ＆Industrial Engineering*,51(2),247－256.

Ma H, Miao Z, Lim A(2011).Cross docking distribution networks with setup cost and time window constraint. *Omega-International Journal of Management Science*,39,64－72.

Cheng, T.C. E, Wang G(1998). A Note on Scheduling Alternative Operations in Two-Machine Flow shops. *The Journal of the Operational Research Society*,49(6), 670-673.

Chen F, Lee C Y(2005).Minimizing the make span in two-machine cross docking scheduling. *European Journal of Operations Research*,5,102－131.

Chen Feng, Song Kailei(2006).Cross Docking Logistics Scheduling Problem and its Approximative and Precise Algorithms. *Industrial Engineering and Management*,6,53-58.

Shi Wen, LIU Zhixue, LIU Dan(2013).Key factors of parts for milk-run and cross-docking systerm: Dseign and analysis of simulation experiments method. *Journal of Management Sciences in China*,16(6),22-34.

MIAO Zhaowei, YANG Feng, XU Dongsheng, SHI Ning(2011).A self-adaptive genetic algorithm for the transshipment problem through cross docks. *Journal of Management Sciences in China*,14(6),24-35.