ATLANTIS PRESS

*Advances in Social Science, Education and Humanities Research, volume 309*

1st International Symposium on Management and Social Sciences (ISMSS 2019)

# *Path Choosing of Logistics Service Upgrading Driven by Big Data*

## Empirical Study Based on AHP model

Jie Ma
Business and Management Dept.
Beijing Polytechnic
Beijing, China

***Abstract*—With the rapid development of Big Data technology, it strongly drives logistics service upgrading. As for logistics companies, how to choose a proper path of service upgrading by using big data is a question. This paper is trying to analyze the upgrading paths and their impact factors. Then An empirical study is made on a sample company by constructing an AHP model, which includes target layer of path choosing, criterion layer of eight impact factors and solution layer of four possible paths. According to the situation of the sample company and experts discuss, the indexes are rated and calculated. The sequence of path choosing for the sample company to upgrade its logistics service by using Big Data is concluded as a result. The paper provides a new aspect to research logistics service upgrading driven by big data. The outcome is worthy to logistics companies when choosing a service upgrading path.**

***Keywords—Big Data; Logistics service upgrading; path choosing; AHP model***

## I. INTRODUCTION

Since 2014, the logistics industry of China has moved into a period of transforming and upgrading, which requires the corporations lengthen service chain, increase service items, enhance service efficiency and quality, change operation modes [1]. In the meantime, the application of Big Data technology to logistics fields has been popular and important, which constitutes a driving strength for transforming and upgrading. Moreover, one of the key advantages of Big Data is to accelerate service innovation [2]. Some scholars found that making decision by Big Data brings 6% more profit than other competitors [3].

Many researchers studied on this field. According to the periodical paper index, the numbers of papers relevant to the topic of "logistics+ Big Data" increase nearly 8 times in recent five years. And in these papers, the most popular words include "upgrading", "innovation", "service" and so on. Some of the former research focused on the industry level. The most representative one is the book "Big Data and Intelligent Logistics" written by Wang. Xifu in 2016 [3], which explained the impact of Big Data on logistics business modes and structure systems and designed the operational framework of intelligent logistics based on Big Data. Ji. Guojun (2016) researched the decision framework of full channel supply chain innovation mainly about the impact factors [4]. Ji. Feng (2016) studied on the impact mechanism and driving factors of Big Data to enterprises' transformation [5]. There are also some papers focused on specific fields of logistics industry such as agricultural products logistics [7] and apparel industry supply chain [8]. Former research more focused on theoretical statement and didn't provide available path to apply Big Data in logistics service upgrading at company's level.

This paper takes companies as the research objects. It surveys and analyzes the demand and impact factors for using Big Data in service upgrading. And the AHP method is used to evaluate the degree of those factors' impact on specific company and on possible paths generally.

## II. DEMANDS OF USING BIG DATA IN SERVICE UPGRADING

### *A. From the aspect of activity*

There are many activities relevant to logistics services involved in the process of supply chain, which need Big Data to enhance the efficiency or quality. Through questionnaire survey, 63 logistics companies rate the needs for Big Data used in several activities with 1 to 5 scores. Bigger the score is, more urgent Big Data is needed. According to the feedback of survey, activities such as accurate marketing and personalized service, forecasting and inventory control, cargo allocation to different distribution centers, cost analyzing, picking route optimizing and intelligent replenishment to picking area in distribution center are all rated above 3.8 in average, which means around two thirds sample companies are in need or in urgent need of Big Data to accomplish those logistics activities. Other activities are rated between 3.68 to 3.78 include distribution or transportation route planning, trucks and drivers scheduling, site selection of distribution centers, storage location allocation, value-added service design and service mode innovation [9].

### *B. From the aspect of degrees*

As the application degree of Big Data technology goes deeper and deeper, the demands of logistics companies for Big Data may begin with visualization of management data or index, which helps with business display and evaluation [10]. Then some models and calculation will be introduced to help

Sponsored by: (1)general projects of social science program of beijing municipal commission of education, "research on talents competency in the accelerated upgrading context of beijing logistics industry"(sm201810858002); (2)beijing polytechnic, "research on supply chain and logistics service upgrading driven by big data"(2017z008-003-sxz);(3)research team on the integration of e-commerce and logistics(cjgx2018-szjs-007/005);(4)academic leader(cjgx2018-szjs-007/004).

with forecasting and analyzing. The deepest application is using Big Data to make decision intelligently. According to the feedback of survey, the above three degrees of applications and demands are equally rated over 3.7.

## III. POSSIBLE PATHS OF USING BIG DATA IN LOGISTICS SERVICE UPGRADING

As mentioned above, logistics companies need Big Data in many activities in varying degrees. As far as a company is concerned, four possible paths can be concluded.

### A. *Upgrading of service efficiency*

Upgrading of service efficiency means higher speed and lower cost, which is a direct path to upgrade logistics service. Among the activities in need of Big Data mentioned, distribution and transportation route planning, trucks and drivers scheduling, picking route optimizing in distribution centers, intelligent replenishment to picking area, cost analyzing all help to accelerate the services and control costs. Displaying visualized big data relevant to the above activities is easier technically, which helps managers to find the questions and solutions faster. If more efficiency is requested, to more deeper degrees should the Big Data be used such as data mining and modeling.

### B. *Upgrading of service quality*

Upgrading of service quality means more accurate response to the clients, which is a key path to upgrade logistics service. Among the activities mentioned, using Big Data in demand forecasting, inventory control helps to enhance the accuracy rate of inventory which is one of the key performance indexes taken seriously by logistics clients. And based on the usage of Big Data of sales, clients and service products, the logistics companies could implement more accurate marketing which directly enhances the satisfaction of the clients. The degrees of application include sharing visualized inventory data to specific clients, mining and calculating preference of specific clients.

### C. *Upgrading of service function*

Upgrading of service function means developing value-added services or more service items based on the original basis services, which is a path with significant effect to lengthen logistics service chain and extend logistics service functions. Many activities the above mentioned could be taken into this account. For example, a logistics company could find more proper site of distribution points and volume of inventory for its clients based on distribution data mining and analyzing.

### D. *Upgrading of service mode*

Upgrading of service mode means kind of transform or change of the way to earn profit, which is the most advanced path for service upgrading and subsequently requires stronger purpose and more resources. As a result, this kind of upgrading possibly leads a logistics company to a completely new and fast developing market. According to specific survey, one of the sample logistics companies is trying to develop a warehousing platform for cross-border E-commerce based on long-term third-party warehousing business. The main clients of this sample company change from cargo owners to warehouse providers.

## IV. IMPACT FACTORS OF USING BIG DATA IN LOGISTICS SERVICE UPGRADING

In order to evaluate how the possible upgrading paths are influenced by several impact factors, an AHP model is constructed and fuzzy comprehensive evaluation is used.

### A. *AHP model*

The AHP model includes target layer of path choosing, criterion layer of eight impact and constraint factors and solution layer of four possible paths as illustrated in Fig. 1.

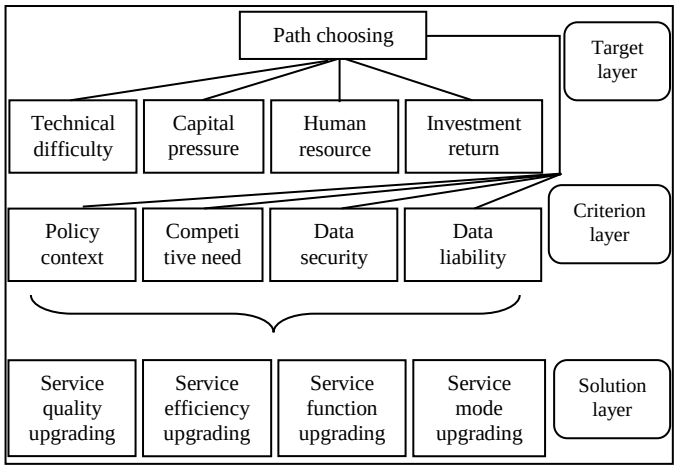


FIG. 1: AHP MODEL FOR PATH CHOOSING

### B. *Explanation of impact factors*

According to survey and experts discuss, the upgrading path choosing is mainly subject to eight internal or external factors.

- Factors of technical difficulty, capital pressure, human resource and investment return are all internal ones, which mean the request of the upgrading path for Big Data technology, employees' competency and financial investment. Upgrading of service mode usually needs more difficult technic, more investment of money and human resource than other paths. Due to large investment and obvious change in business and organizational structure, the investment return cycle of service modes upgrading is usually longer.
- Factors of policy context and competitive need are both external ones, which are the constraint strength against upgrading. The more innovation is required by the upgrading path, the stronger constraint is from competitive environment and bigger push is from government's policy.
- Factors of data security and liability pay attention to another kind of concerns from the internal or external. If one of the upgrading paths lead to business data

leakage, require stronger data protection or higher data liability, the company should make decision after full balance.

### C. Fuzzy comprehensive evaluation and calculation

In order to make a quantitative analysis on path choosing basis, the constraint degree of each factor on each possible upgrading path is graded from 1 to 5 scores through general survey and specific counsel [11]. The bigger the score is, the less possible the upgrading path is chosen under the same circumstances of factors. The comprehensive weight of each factor constraining each path is shown in Table 1.

TABLE I. TABLE 1: WEIGHT OF FACTORS CONSTRAINING EACH PATH

| Criterion layer-solution layer | Service quality upgrading | Service efficiency upgrading | Service function upgrading | Service mode upgrading |
|---|---|---|---|---|
| Technical difficulty | 0.1319 | 0.1417 | 0.3136 | 0.4128 |
| Capital pressure | 0.1283 | 0.1378 | 0.2565 | 0.4774 |
| Human resource | 0.1453 | 0.1608 | 0.2705 | 0.4233 |
| Investment return | 0.2274 | 0.2274 | 0.1222 | 0.4231 |
| Policy context | 0.3647 | 0.2771 | 0.233 | 0.1252 |
| Competitive need | 0.2428 | 0.0991 | 0.2194 | 0.4387 |
| Data security | 0.1985 | 0.1306 | 0.1847 | 0.4862 |
| Data liability | 0.1424 | 0.0861 | 0.2651 | 0.5065 |

### D. Outcomes

- As for service quality upgrading, the strongest pushing factor is lower capital pressure and technical difficulty, which could be obtained more easily by a company.
- As for service efficiency upgrading, the strongest pushing factor is data liability and competitive need. The data used to enhance service efficiency mostly comes from the internal which is more liable. And the competition of service speed and cost is the fiercest in logistics market.
- As for service function upgrading, the strongest pushing factor is investment return. The investment in developing value-added services is not very much. Due to the close connection between new service items and former service items, the clients are usually willing to pay for the value-added services.
- As for service mode upgrading, the strongest pushing factor is policy context. Innovation of new business modes based on new technology such as Big Data is welcomed by the government and industry

## V. EMPIRICAL STUDY

As shown in Chart 1, the target of path choosing depends on two layers indexes including criterion layer and solution layer. It is explained in last part that how each solution is usually influenced by each factor. However, it is different for companies that how each impact factor is considered in path choosing. So, the AHP model can be used in empirical study.

### A. The sample company

The sample company is a large private enterprise with more than 5000 employees and about 1.5 billion assets. It specializes in logistics and supply chain management covering traditional business of warehousing, distribution, road transportation, international freight forwarding and supply chain counseling mostly for small clients. The company is facing the problem of choosing proper upgrading paths in the context of industrial environment driven by Big Data

### B. The sample company's evaluation to impact factors and relevant calculation

The constraint strength of each factor is evaluated by senior managers of the sample company with 1 to 5 scores based on pairwise comparison as shown in Table 2. Then the impact weight of each factor on target of path choosing could be calculated as shown in Table 3.

TABLE II. TABLE 2: SCORE OF FACTORS BASED ON PAIRWISE COMPARISON

| Factors | TD | CP | HR | IR | PC | CN | DS | DL |
|---|---|---|---|---|---|---|---|---|
| Technical difficulty (TD) | 1.00 | 4.00 | 0.50 | 3.00 | 3.00 | 2.00 | 3.00 | 2.00 |
| Capital pressure (CP) | 0.25 | 1.00 | 2.00 | 2.00 | 3.00 | 1.00 | 0.50 | 0.50 |
| Human resource (HR) | 2.00 | 0.50 | 1.00 | 4.00 | 5.00 | 3.00 | 3.00 | 3.00 |
| Investment return (IR) | 0.33 | 0.50 | 0.25 | 1.00 | 2.00 | 2.00 | 1.00 | 1.00 |
| Policy context (PC) | 0.33 | 0.33 | 0.20 | 0.50 | 1.00 | 0.50 | 0.50 | 0.50 |
| Competitive need (CN) | 0.50 | 1.00 | 0.33 | 0.50 | 2.00 | 1.00 | 1.00 | 1.00 |
| Data security (DS) | 0.33 | 2.00 | 0.33 | 1.00 | 2.00 | 1.00 | 1.00 | 2.00 |
| Data liability (DL) | 0.50 | 2.00 | 0.33 | 1.00 | 2.00 | 1.00 | 0.50 | 1.00 |

Random Consistency Ratio equals 0.086 < 0.1, the consistency is acceptable.

TABLE III. TABLE 3: IMPACT WEIGHT OF FACTORS ON PATH CHOOSING

| Target layer-criterion layer | TD | CP | HR | IR | PC | CN | DS | DL |
|---|---|---|---|---|---|---|---|---|
| impact weight | 0.217 | 0.107 | 0.244 | 0.089 | 0.049 | 0.089 | 0.109 | 0.097 |

As for the sample company, the strongest constraint factors against service upgrading driven by Big Data are human resource and technical difficulty. It also reveals one of the representative internal shortages of traditional third-party logistics companies. The strongest pushing factors are external ones including policy context and competitive need, which shows that the external environment calls for service upgrading driven by Big Data.

Further calculation is made to get the aggregate weight of each path based on the weight of two layers in Table 1 and Table 3. The outcome is shown in Table 4.

TABLE IV. TABLE 4: AGGREGATE WEIGHT OF EACH PATH

| Target layer-solution layer | Service quality upgrading | Service efficiency upgrading | Service function upgrading | Service mode upgrading |
|---|---|---|---|---|
| Technical difficulty | 0. 0286 | 0. 0308 | 0. 0681 | 0. 0897 |
| Capital pressure | 0. 0137 | 0. 0148 | 0. 0275 | 0. 0511 |
| Human resource | 0. 0354 | 0. 0392 | 0. 0659 | 0. 1031 |
| Investment return | 0. 0202 | 0. 0202 | 0. 0108 | 0. 0375 |
| Policy context | 0. 0178 | 0. 0135 | 0. 0114 | 0. 0061 |
| Competitive need | 0. 0215 | 0. 0088 | 0. 0195 | 0. 0389 |
| Data security | 0. 0217 | 0. 0143 | 0. 0202 | 0. 0532 |
| Data liability | 0. 0138 | 0. 0083 | 0. 0256 | 0. 0490 |
| Aggregate weight | 0. 1727 | 0. 1498 | 0. 2489 | 0. 4286 |

The aggregate Random Consistency Ratio equals 0.0165 < 0.1, the consistency is acceptable.

### C. Outcomes

As far as the sample company is concerned, service efficiency upgrading is the most possible path, then comes service quality upgrading, service function upgrading. However, service mode upgrading is subject to the strongest constraints.

- Based on its original transportation, forwarding and warehousing services, the sample company could attempt to display operational process and performance visually in the context of Big Data, which helps with faster decision making and timelier customer response. To meet the demand of service efficiency upgrading, the sample company should seek for competent human resources and technical support since these two factors are the strongest constraints.
- Furthermore, mining of sales data especially for those small clients of road transportation and international freight forwarding services helps to provide more accurate services to specific categories of market. Sales data is usually from the internal and relatively liable for any analysis.
- Service function upgrading should be taken into account by the sample company when technics and human resources are ready. The value-added services could be developed in several fields such as connection of warehousing and transportation, extend to purchase and supply service in the upstream of supply chain or distribution service in the downstream.
- Service mode upgrading is not recommended to the sample company in a short period of time due to the high limitation of technic, human resource and capital.

## VI. CONCLUSION

- Four possible service upgrading paths driven by Big Data are presented and explained from the aspect of logistics companies. Service efficiency upgrading, service quality upgrading, service function upgrading, and service mode upgrading is respectively regarded as the direct, the key, the significant and the most advanced path to upgrade logistics services.
- Eight impact factors are considered as constraint conditions of service upgrading driven by Big Data, which cover internal and external factors.
- An AHP model is structured and fuzzy comprehensive evaluation is used for quantitative analysis on path choosing influenced by eight impact factors. The strongest pushing factor is found for each path based on general survey. The AHP model is used for empirical study on a sample company. Based on its senior managers' evaluation on each factor, calculation is made to get the aggregate weight of the factors considered when choosing upgrading path driven by Big Data. The choosing sequence of upgrading path for the sample company is concluded.

## Acknowledgment

The research gained strong supports of more than sixty professional practitioners from different logistics companies during survey and specific interview. This paper also referred to many scholars' outcomes. I appreciate them very much. Meanwhile, thanks to my team members for their hard works.

## References

[1] Ma. Zhongjian, "Transformation and Upgrading of Traditional Logistics Enterprises Enabled by Intelligent Supply Chain and Big Data," China Logistics & Purchasing, pp.96, vol. 24, 2018. (in Chinese)

[2] Davenport, Thomas, "Big Data at Work: Dispelling the Myths, Uncovering the Opportunities," Harvard Business Review Press, pp. 134-135, 2014.

[3] McAfee A E，Brynjolfsson, "Big Data: The Management Revolution," Harvard Business Review，pp. 23-26, vol.10, 2012.

[4] Wang. Xifu, "Big Data and Intelligent Logistics," China Machine Press, pp. 27-30, 2016. (in Chinese)

[5] Ji. Guojun, Yu. Muhong, and Kim. Huatan, "Decision Framework for Full Channel Supply Chain Innovation Driven by Big Data," Business Research, pp. 152-162, August 2016. (in Chinese)

[6] Ji. Feng, Zhang. Ting, Wu. Fan, "The Impact of Big Data Ability on Internet transformation of Traditional Enterprises: Based on The Aspect of Supply Chain Flexibility," Academics, pp. 68-78+326, February 2016. (in Chinese)

[7] Zhang. Tianqi, "The Bottleneck And Breakthrough of Agricultural Products in Big Data Times," Journal of Commercial Economics, pp.10-12, vol. 18, 2014. (in Chinese)

[8] Zhou. Xingjian, "Research on Apparel Supply Chain Operational Mode Based on Logistics Big Data," Fashion Guide, pp.17-21, April 2015. (in Chinese.

[9] P Thamilselvana, J.G.R.Sathiaseelan. A Comparative Study of Data Mining Algorithms for Image Classification[J]. International Journal of Education and Management Engineering, 2015, 5(2):1-9.

[10] Kajol R, Akshay Kashyap K, Mr. Keerthan Kumar T G. Automated Agricultural Field Analysis and Monitoring System Using IOT[J]. International Journal of Information Engineering and Electronic Business, 2018, 10(2):17-24.

[11] Meghna Sharmaa, Manjeet Singh Tomerb. Predictive Analysis of RFID Supply Chain Path Using Long Short Term Memory (LSTM): Recurrent Neural Network[J]. International Journal of Wireless and Microwave Technologies, 2018, 8(4):66-77.